CONTENTS

OF THE

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CONTENTS

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

The June Conventions.

EARLY summer seems to be the most popular time for conventions of all sorts. The June delegate is almost as prevalent as the June bride. The efficiency howlers will probably joy in this fact, citing the economy of combining the convention trip with the honeymoon. Possibly they are right, but it seems to us as if a combination of this sort would be unreasonably in restraint of trade. Be that as it may, June is certainly the convention month. Starting at the last of May with the National Electric Light Association meeting in New York and finishing in Boston with the Association of Railway Telegraph Superintendents, there is something doing all the time.

The conventions of greatest interest to railroad electrical men are those in Washington, Atlantic City and Boston. The work of the Master Car Builders and Master Mechanics Associations as well as that of the Telegraph Superintendents, is inevitably bound up with that of the Railway Electrical Engineers.

The convention at Washington is the third semi-annual meeting of the last-named Association and will chiefly be concerned with the work of the regular committees, which covers practically all the various unsettled points in railway practice. All these committees are working towards standardization of equipment and practice, for only by standardization can the greatest excellence and economy of operation be attained.

Chicago's Greatest Terminal.

WITH the opening this month of the new Chicago & North Western Terminal Station, Chicago takes rank in the matter of railway terminal facilities with any city in the country. No money has been spared to make this terminal perfect in every way. It is interesting to note the many ways in which electricity has helped to bring about this perfection. Only by electricity could such lighting effects as are here seen, have been achieved. Electricity handles all baggage and directs through the signal towers the movements of all trains. It seems too bad that the railway officers could not see their way clear to adopt electric traction as well, and thus do away with the smoke which is the station's only disagreeable feature.

Directly across the street from this terminal is the plot of ground which will probably be the site of another terminal fully as large and imposing, which will take charge of the passenger traffic of the Pennsylvania, Chicago, Milwaukee & St. Paul and Chicago, Burlington & Quincy Railroads, and possibly others. When this is completed, the two will form practically a Union Station of great convenience for through passengers.

The Drawn Wire Tungsten.

THE general adoption of the drawn tungsten wire for lamp filaments marks another step in the development of the incandescent lamp. When new this wire shows remarkable tensile strength, varying from 451,000 pounds per square inch in the 100-watt size, to 737,000 pounds in the 25-watt. Figures are not available, but presumably the strength of the filament in the smaller lamps most used in railway work is even greater. The strength of these wires is over 12 times as great as that of structural steel which averages about 60,000 pounds per square inch. A large proportion of this strength is lost when the lamp is burned, but it is claimed that the wire never entirely loses its ductility, and so far as sturdiness goes, it is a great improvement over the pressed filament.

Volume Two Index.

AS a supplement in this issue will be found an index of Volume Two, which closed with the May number. The beginning of a new year in the life of any enterprise is always a time of reckoning and often a time of felicitation. Just now we are too busy to do any felicitating so we will simply say that on looking back over the past twelve numbers it seems to us that Volume Two has shown an improvement over Volume One and on looking ahead we are dead sure Volume Three is going to show an equal improvement over Volume Two.

ASSOCIATION NEWS.

This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.

It will be open to communications pertinent to association matters. Any member who has anything to say to the other members is invited to make use of this column for that purpose. Such communications should be addressed to the secretary of the association.

SEMI-ANNUAL CONVENTION.

The semi-annual convention of the Association of Railway Electrical Engineers will be held June 16 and 17 in the rooms of the Washington Terminal Station at Washington, D. C. These dates will permit the members to attend both the Master Mechanics and Master Car Builders conventions at Atlantic City if they so desire. The M. M. convention takes place June 14-17 inclusive, and the M. C. B. convention dates are June 19-21 inclusive. The manufacturers' exhibit on the steel pier at Atlantic City will be open from the 14th to the 21st.

Program.

The program for the Washington convention has been announced by Secretary Andreucetti as follows:

Minutes of previous meeting.

Address of president.

Report of secretary-treasurer.

Unfinished business.

New business.

Reports of all standing committees. (For a list of these, see Association Directory, advertising page 22.)

Miscellaneous business.

The first meeting will convene Friday, June 16, at 9:30 a. m., and it is hoped that all business can be finished by Saturday noon. Arrangements in Washington have been made by N. E. Van Buskirk.

Washington Hotels.

The following is a list of Washington hotels, rates and distances from the Washington Terminal Station:

Willard, Pennsylvania avenue and Fourteenth street, N. W.; European, $2.50 up, 17 blocks.

Raleigh, Pennsylvania avenue and Twelfth street; European, $2.50 up, 15 blocks.

Ebbit House, Fourteenth and F streets, N. W.; European, $2.50 up, 17 blocks.

Hotel Continental, opposite Union Station; European, $1.50 up, 200 yards.

Metropolitan, Pennsylvania avenue and Sixth street, N. W.; European, $1.50 up, 10 blocks.

National, Pennsylvania avenue and Sixth street, N. W.; European, $1.50 up, 10 blocks.

Harris, Pennsylvania avenue and North Capital street; European, $1.00 up, 10 blocks.

St. James, Pennsylvania avenue and Sixth street, N. W.; European, $1.50 up, 10 blocks.

SECRETARY ANDREUCETTI MOVES.

The offices of A. J. Farrelly, electrical engineer of the C. & N-W. Railway have been moved from 323 W. Kinzie St. to Room 411, Northwestern Terminal Station, Chicago, Ill. Mail for J. A. Andreucetti, assistant electrical engineer and secretary of the Association should hereafter be sent to the latter address.

CAR LIGHTING CLUB.

The May meeting of the Car Lighting Club, the last of the present season, was held at the Chicago Press Club, May 17.

The subject for the evening was "Conduit in Railway Work."

The paper on this subject, an abstract of which appears below, was read by Mr. J. Andreucetti, following which several of the conduit manufacturers' representatives described different brands of conduit.

F. R. Bryant (American Conduit Co.) brought out the fact that no matter how good the galvanized covering, corrosion would take place rapidly in ordinary steel. For this reason a new alloy, called Spellerized metal, is now being used for conduit manufacture.

Mr. O. L. Richards (Safety-Armorite Co.) emphasized the advantage of practical tests under actual service conditions over the theoretical tests made in laboratories by consulting engineers. He said that the consulting engineer, no matter however authoritative and impartial he may be, is unconsciously influenced by the fact that he is getting his compensation from the conduit company.

Mr. V. A. Sweet (Sprague Electric Co.) described the process of manufacture of the Greenfield Flexible Conduit, and raised the objection to pipe conduit that condensation of moisture may form water pockets which injure the insulation of wires.

Mr. B. F. Webb (American Circular Loom Co.) described the X-duct pipe conduit, the peculiar feature of which is that it has an outer coating of copper as well as zinc. Advantages of the Sherardizing process for pipe protection were discussed by several members.

The consensus of opinion seemed to be that ventilation of a car lighting conduit system was entirely unnecessary, and any attempts in that direction would only result in having the conduit fill with dust.

A number of questions were then asked by different members as follows:

1. Is a multi-speed fan desirable for railway car work?

The general opinion seemed to be that it was not desirable and that one speed satisfied all the ordinary requirements. Mr. W. M. Lalor raised the question as to whether the three speeds were an advantage in motor starting. Inasmuch as the fan is invariably thrown immediately on the high speed, this was thought not to be the case. Mr. C. R. Gilman stated that the speed of fans at present was often too high, and that the middle speed should be adopted for all fans.

2. What is the best method of lighting and wiring roundhouses?

Mr. E. W. Jansen (I. C.) thought that five years' service without trouble of any kind had proved pretty conclusively that his method was the best. This method was described in detail in the Railway Electrical Engineer, June, 1909. The main feature of it is that the line wires are carried on glass insulators outside the building, while all interior wiring is placed in conduit on 2x6 wooden beams 14 feet from the floor or below the steam line. One of the biggest problems in lighting of roundhouses is to prevent the stealing of the lamps, and the ultimate solution will probably be the use of the 250 or 400 watt Tungsten lamp between each stall or between every other stall, placed under a reflector and high enough to illuminate all parts of locomotives.

3. Explain how to apply an axle pulley.

In answer to this question F. R. Frost said that on the Santa Fe, malleable cast pulleys are applied with a shimming of tar felt. Tapered axles are still in use on this road.

4. Does the ampere-hour meter give an accurate indication of the condition of the battery?

Not necessarily, but it gives a good idea of the efficiency at which the battery is working.

Mr. Hutchinson stated that when an ampere hour meter was first installed on a car running between Chicago and El Paso, the difference between battery input and output was 1,200 ampere-hours, the generator being set to charge at the 50 ampere rate. By cutting down this charging rate it was found possible to operate the battery with a difference between input and output of only 80 ampere-hours.

5. Is it desirable to have a joint baggage man-electrician-expressman?

This is practiced on the Northern Pacific and Great Northern roads. However, it is probably not advisable as the financial responsibility of baggageman to the express company is very likely to result in his neglecting the electric lighting equipment.

A committee was appointed to select subjects and speakers for next year, to decide upon places of meeting, and arrange for entertainment features.

This committee consists of C. R. Gilman, chairman; E. W. Jansen, H. G. Myers, A. I. Totten, F. W. Bender and Geo. W. Cravens.

There was also appointed a Committee on Interest, consisting of Geo. Colegrove, chairman; F. E. Hutchinson and H. G. Myers.

The next meeting will be held Wednesday, Sept. 20, 1911, place and subject to be announced later.

Conduit in Railway Service

A few years ago the man who undertook to discuss the use of conduit for ordinary wiring would have had to show cause. Wooden moulding was regarded as ample protection for insulated wires, and metal conduit looked upon as an unwarranted luxury. Undoubtedly metal conduit costs more than wooden moulding. Experience has shown that it is worth more.

It might not be out of place here to define an interior conduit as a metallic tube for completely enclosing insulated current-carrying wire. That definition covers them all.

Reasons for Use.

The objections found to wooden moulding (which of course is still in very general use, and which is permitted in most places by the fire underwriter's rules) are: First, the tendency of the insulation it affords to break down from dampness and, second, the danger of heating when the wires are overloaded. Both these are fire dangers. A third objection is that a moulding is such a convenient place to drive nails. And nails are not good for current-carrying wires.

These difficulties have been the strong arguments in favor of the use of metallic conduit.

Now in spite of the claims of the rival conduit manufacturers, there are really only two distinct kinds of metal conduit—those made from iron pipe and those made from sheet iron or steel.

The first conduit used was ordinary iron gas pipe. In a dry and sheltered place this answers very well. But if it is subject to more or less moisture it corrodes rapidly and goes to pieces entirely in a few years. The progress in the development of this kind of conduit has been along the line of protection from this corrosion. The most common method is by the deposition on its surface of a layer of zinc or copper. There are several processes by which this deposition is effected. Either of these metals is much less subject to corrosion then iron, and so lengthens the life of the conduit. But, of course, once the surface layer is penetrated corrosion goes ahead again as rapidly as if there had been no deposition. Some times a layer of paraffine is put on over the zinc. A coat of enamel is also used as a protection for the outside of the pipe, and has been very generally adopted for the inside lining. This enamel is supposed to be more or less flexible so that a slight bend in the pipe will not break the lining. Some conduit is zinc lined inside. The enamel lining has the advantage of a greater smoothness. Pipe conduit is less expensive than other metallic conduits. For any enclosed and concealed wiring it is best and most economical. The fact that it must come in regular lengths is a disadvantage on account of the cutting and fitting where the distance between outlets is short. Its lack of flexibility is also a disadvantage for some work. It is not very ornamental and is best out of sight.

The conduit made from sheet metal is either bent into the form of small boxes or spirally wound of zinc-coated iron or steel. This style is more ornamental than pipe, and I believe more expensive. It is best suited to interiors of buildings where the wiring for some reason must be exposed.

The spirally wound type has the advantage of greater flexibility. Turns can be made with this conduit without cutting the tube or in any way injuring the covering.

For wiring old buildings or any place where the wiring must follow a devious and not easily accessible path, this conduit has a great advantage. It is probably not as durable as pipe and I do not think the clamp joints used with it are as good as the threaded joints of pipe.

As has been said, the chief progress in the development of conduit has been on improvement in its lasting qualities, and this improvement has been brought about by the use of a surface not subject to chemical action where water is present.

There are few cases in which conduit is subject to severe mechanical wear, but we have some of them on Railway work. Besides the metallic conduits, there are a number of flexible fibrous wire cases going under such trade names as, "Braiduct" "Flexduct," etc.

Railway Uses for Conduit.

In Railway work conduit is used for building wiring, shop wiring, and car wiring. There is nothing unique about the building wiring unless it is in train shed wirng, where the smoke and fumes from locomotives make the tendency to corrosion greater than in most places.

In the wiring of motor driven machine tool shops, conduit is absolutely necessary and nothing less than the best for each installation should be used. Not only are the conductors carrying heavy loads and subject to greater momentary over-loads, and correspondingly more dangerous, but the nature of the work is such that wiring not properly protected is likely to be injured. Appearances do not count in this work. What we want is a strong suitable conduit not injured by rough use.

In car lighting we have perhaps the severest kind of service to which any conduit is subjected. The wiring of electric lighted cars is carried on the roof where it is subjected to the constant action of locomotive cinders. So powerful is the abrasive action of these cinders that iron pipe is sometimes completely cut to pieces in a few years' service. It would seem that what we want for this work is some unusually hard and tough metal. Under the car conditions are even worse on account of the grinding of the sand from the road-bed.

The Lighting of the New Northwestern Terminal

At six o'clock on the morning of June fourth, the new terminal station of the Chicago & Northwestern Railway was opened for service. This terminal, the finest in Chicago, and one of the greatest in the world, has required five years work and an expenditure of upwards of $23,000,000. It provides for the growth

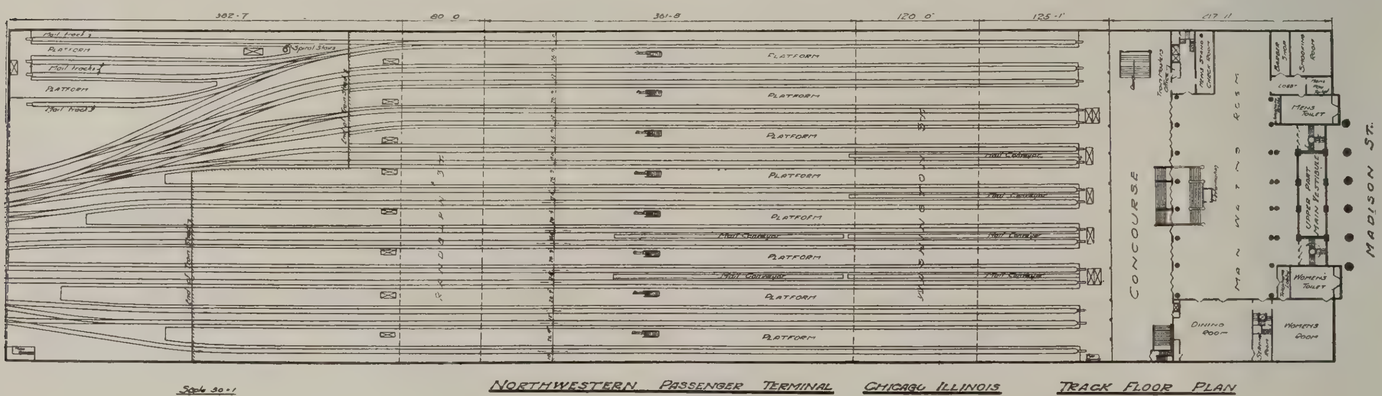
Chicago Terminal Station of C. & N.-W. Ry.

and development of passenger traffic for many years to come and sets a standard of service to the traveling public, undreamed of even 10 years ago.

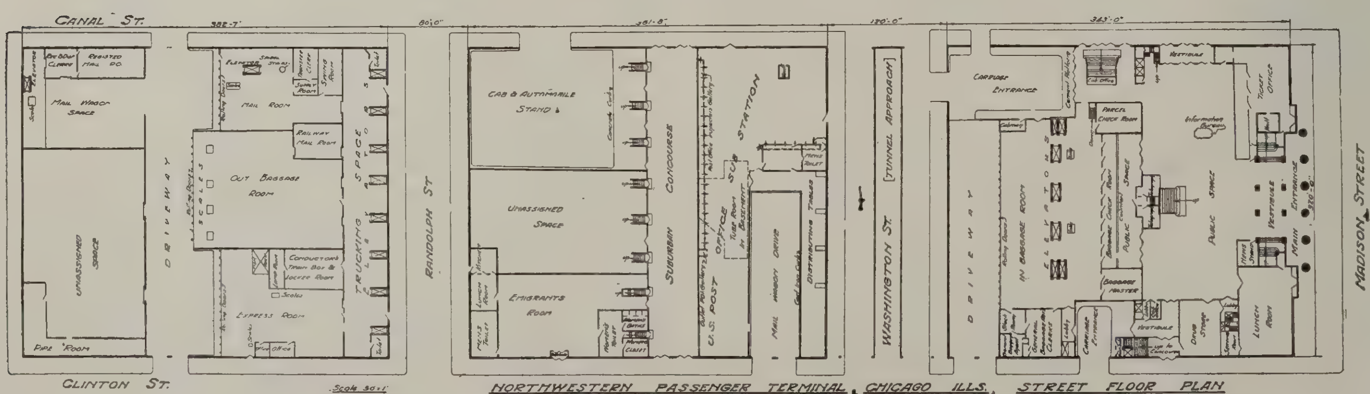
About 300 trains now enter and leave the station every day but the train sheds have been designed to handle 1,500. Sixteen tracks under a train shed 870 feet long are provided. The train shed is of the Bush type with a low roof of reinforced concrete and troughs allowing the smoke and steam from locomotives to escape directly to the outer air.

To describe the station as a whole and do it justice would require several volumes. In subsequent articles the various electrical features will be taken up in detail. Just now we will concern ourselves with only one—the lighting.

The street lighting around the station alone is as much as is used in some small cities. Sixty 4-lamp tungsten clusters on ornamental bronze poles illuminate Madison, Canal and Clinton streets around the station. In addition to these there are four large



North-Western Terminal Station—Floor Plan of Track Level.



North-Western Terminal Station—Floor Plan of Street Level.

standards in the sidewalk on Madison street directly in front of the main entrance. All street lighting is done with incandescent tungsten lamps inclosed in Alba globes.

The vestibule just inside the main entrance is lighted by the indirect system, incandescent lamps placed in large bowls throwing the light onto the white ceiling.

The large room on the ground floor, designated in the accompanying plan as a "Public Space," is lighted by incandescent lamps of large size set in opal globes. To the right, as you go in, are the ticket offices, and to the left a lunch room and drug store. Entrances from Canal street on the right and Clinton on the left are provided. The ticket cases are mounted on casters and can be rolled into position for use at any of the ticket windows. They are lighted by "Linolite" tubular lamps, which throw on even illumination over all the tickets, and are screened from the eyes. The drug store and lunch room are illuminated on the indirect system.

The remaining rooms on the ground floor with the exception of the post-office are lighted with large tungsten units under Alba reflectors. The post-office (Chicago sub-station U), which occupies the ground floor space between the Washington street tunnel approach and the Suburban Concourse, is lighted by Cooper-Hewitt mercury vapor lamps.

From the Public Space on the street level a grand stairway leads upward to the concourse and main waiting room on the track level. The main waiting room, shown in the accompanying cut is an architectural triumph unsurpassed by any similar room in the world. The pilasters are of pink Tennessee marble and the columns of imported marble, delicate green in color. The lighting is accomplished by 20 13-light tungsten clusters in Alba globes and by reflection from the white glazed tile ceiling of the light from 75,000 candlepower in incandescent lamp banks. These lamps are concealed behind the cornice just under the vaulted roof and are fitted with special Alba reflectors which utilize their illuminating capacity to the fullest degree.

To the left of the main waiting room is a splendid dining room lighted by the indirect system from suspended alabaster bowls and offering a service comparable with the best metropolitan hotels or restaurants. To the left, also, are the retiring rooms for women fitted with every comfort and convenience from telephones to manicures.

Corresponding provision for the mere men who settle the bills are provided on the right. Here also is located the news stand and check room.

North-Western Terminal Station—Main Waiting Room.

A novel lighting system has been provided for all the stairs. It consists of small tube lights set in the walls about a foot above the stairs and lighting them slightly more brightly than the surroundings so that, as a railroad man expressed it, "there is no excuse for falling upstairs any time."

The concourse leading to the train sheds is lighted by six groups of 13 globes each suspended by chains from the white tile ceiling. Over each door from the concourse to the train shed is an indicator showing the time of arrival and departure of trains and the points at which they are scheduled to stop. These indicators are operated by perforated patterns similar in principle to the music rolls used in piano players.

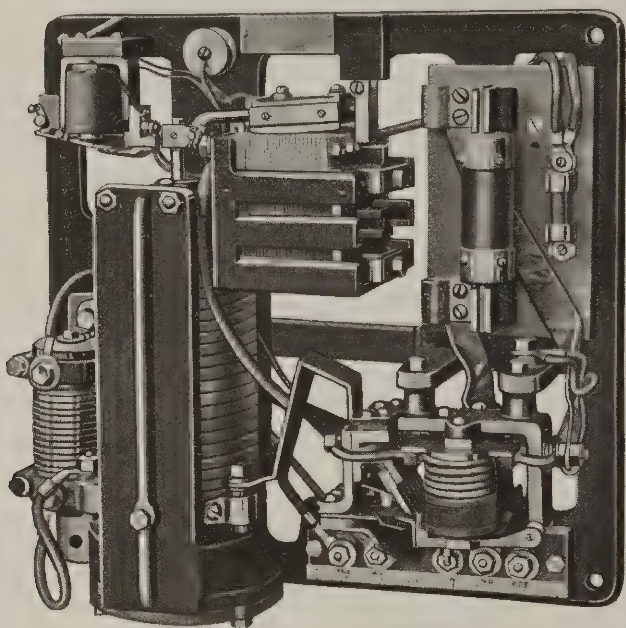
The train sheds are lighted by small incandescent lamps placed under Alba reflectors at frequent intervals over the platforms. No bare lamps are visible here, nor in fact at any other place in the terminal. Everywhere, the rule that light should be "on the object, not in the eye" has been observed.

A New Regulator for Axle Lighting Equipment

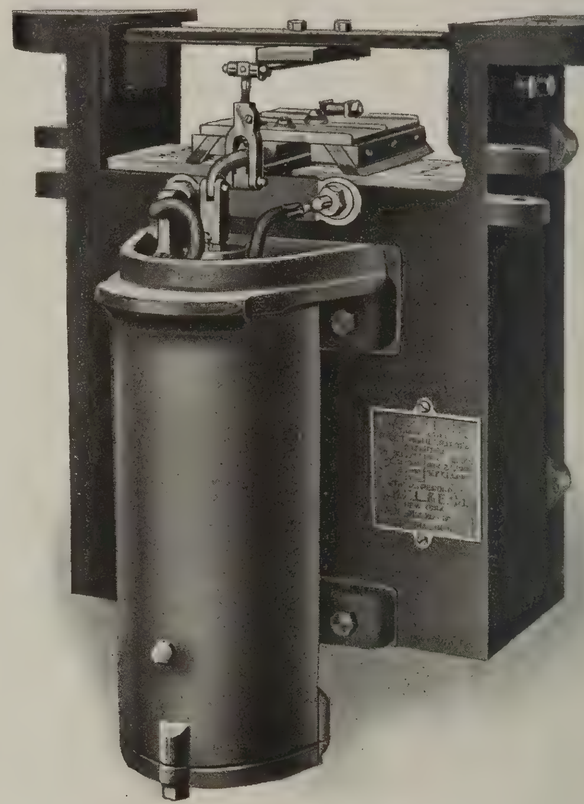
The Consolidated Railway Electric Lighting & Equipment Company is exhibiting a new type of regulator, for which they make claims that appear to be well founded.

In some respects it is a radical departure from their former practice. The regulator has some features that will commend it to every practical railway electrical engineer, chief of which is its extreme simplicity.

It consists of an actuating solenoid, which operates to throw resistance in or out of the circuit to be controlled by direct action of the core on a rocking contact and is



Kennedy Type "L" Regulator—Casing Removed.

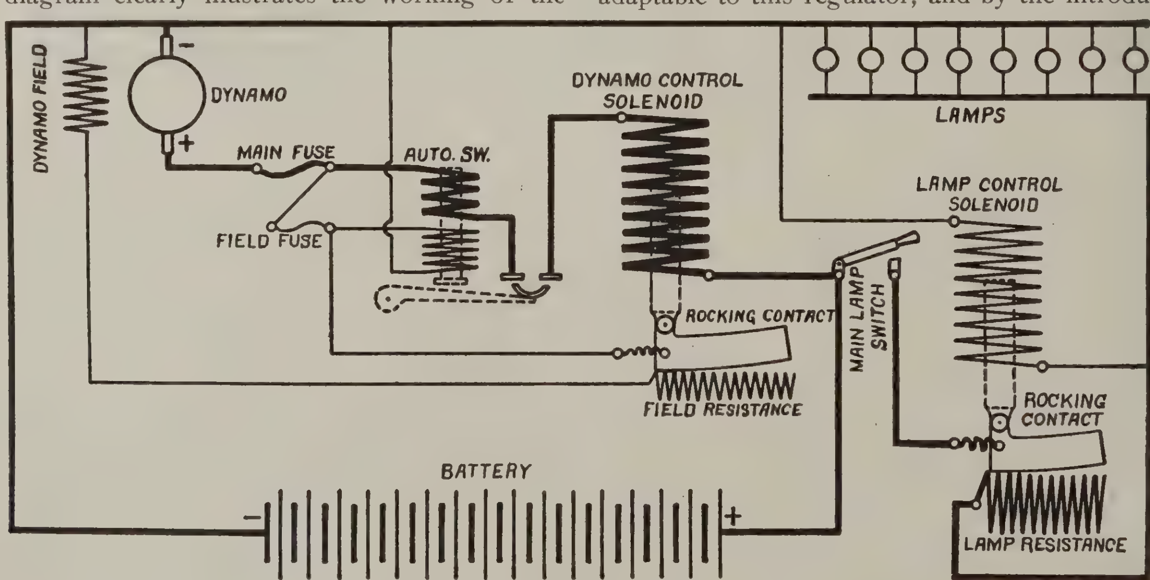


Kennedy Type "L" Regulator—With Casing.

distinguished by the total absence of vibrators or pilot devices and all levers, motors, ratchets, etc. The accompanying diagram clearly illustrates the working of the apparatus. A common metallic resistance in the form of grids is used, thus insuring uniformity of action.

The regulators illustrated herewith are not affected by variations of temperature, are encased so as to be dust-proof and are designed to be placed in a locker of the car, but may be placed under the car if so desired.

By referring to the accompanying wiring diagram, which is typical of the Consolidated Company's system used with the type "L" regulators and thir type "D" dynamo, it will be obvious that any of the well-known methods of stop charge or charge reducing devices are adaptable to this regulator, and by the introduction of a shunt, any part of, or all, of the lamp load may be picked up automatically by the generator. We leave these features out of this diagram, for the purpose of more clearly illustrating the essential features of the regulator.



Wiring Diagram.

Electric Car Lighting

D. F. CRAWFORD

Mr. D. F. Crawford, general superintendent of Motive Power on the Pennsylvania lines west of Pittsburg, writing in the *Yale Scientific Monthly* on "Electric Car Lighting," devotes a large share of his paper to the discussion of storage batteries. His exposition of the theory of the storage battery is very clear. Extracts from his article follow:

In any system of car lighting, the element of greatest importance and the maintenance of which is rather a large per cent of the total cost, is the storage battery. This branch is of such importance, and its development has been so great that the writer feels justified in taking up some time in going into its history, operation and development.

The first practical storage battery was developed in 1860, in France, by Plante. The essential scheme, as outlined by Plante, in the making of the battery was to take two lead plates, sub-merge them in sulphuric acid of about 1,200 degrees specific gravity, and charge and discharge them, forming the active material on the lead, peroxide of lead being formed on the positive plate, and spongy lead on the negative plate. This method is carried out to-day by the American manufacturer of storage batteries, with the exception that various chemical means have been resorted to to increase the rate of the formation of the active material. This process is known as a plante formation, and plates made in this manner are known as "plante plates."

Theory of the Storage Battery.

A satisfactory theory of the lead sulphuric cell is still to be developed, but I will give you the following simple and generally accepted explanation of its action:

We will consider that we have a glass jar filled with 1,200 degrees sulphuric acid, and submerge in it two pure lead plates. Now, with a voltmeter across these plates, we will find that there is no difference in potential. Now, assume that an electric current is passed through this cell, from one plate to the other, calling the plate in which the positive lead is attached the "positive plate" and the other plate the "negative." This current, we will assume, separates the sulphuric acid H_2SO_4 into two parts, or ions "H" and the radical SO_4. The "H" ions move in the direction of the current or toward the negative plate, and so the SO_4 moves against the direction of the current, or toward the positive plate. The hydrogen will be given off as gas bubbles at the negative plate, and the SO_4 radical will unite with the water at the positive plate, forming sulphuric acid H_2SO_4 and liberating oxygen. The oxygen attacks the positive plate, forming a layer of peroxide of lead PbO_2. This process will be kept up until a certain depth of peroxide of lead is formed, then the oxygen will be delivered at the positive plate in the form of gas bubbles, similar to the liberation of hydrogen at the negative plate. Now, if we stop the current, we will find instead of zero potential between the plates that we have a potential of about 2.1 volts, and that the cell is capable of discharging; that is, producing current in an outside circuit, and will give up about 75 per cent of the energy that has been imparted to it. The action in the cell on discharge is opposite to that on charge, and the hydrogen which is liberated at the positive plate will reduce the peroxide PbO_2 to lead oxide which is an unstable combination, and will unite with the free sulphuric acid, forming lead sulphate or $PbSO_4$, while the oxygen delivered at the negative plate will form lead oxide which will unite with the sulphuric acid forming lead sulphate, and, we have the cell in normally discharged condition, or both plates covered with lead sulphate. On again charging the cell, that is, passing current through it from positive to negative from an outside source, the same action will take place as on the original charge, with the exception that at the negative plate the hydrogen instead of being liberated will unite with the lead sulphate $PbSO_4$ forming sulphuric acid and reducing the $PbSO_4$ to metallic lead, which lead, however, is not in its original form, but is in a looser allotropic form, known as spongy lead. We then have the plate in its normal charged condition; the positive plate having a coating of PbO_2, or probably PbO_3, which is of a dark brown color, and the negative plate covered with spongy lead, which is light gray in color. As in the first case, the charge can be continued, the peroxide being formed on the positive plate and the spongy lead on the negative plate, until the action has reached a certain depth, when, as before, hydrogen will begin to be delivered at the negative plate and oxygen at the positive plate, indicating the full charge of the battery.

Now, with a plain lead sheet this action of charge and discharge can be continued with gradually increasing capacity of the element until the active material has reached such a depth that it will mechanically slough off at the same rate at which it is formed. The capacity depends upon the amount of active material, and, as this amount of active material depends upon the surface exposed, the development of the plante plate has been along the lines of increasing the exposed surface of the plate and still maintaining the mechanical strength, and this has been done by the various methods of molding, cutting, or rolling the sheet, so as to form ribs or grid condition, to increase the ratio of the active surface to the projected surface of the plate.

The Faure or "Pasted" Type.

A wide departure from the plante was made in 1878 by Faure and Metzger, in Germany, in the invention of what is known as the "Faure" or "pasted plate." Instead of depending upon the electrochemical formation of active material on the surface of the plate, Faure took a sheet of lead and punched it full of holes, or, in some cases the grid is cast, and, the holes or recesses thus formed are pasted full of a mixture of red lead and sulphuric acid. This paste, or litharge, as it is called, in the recesses of the plate forms a hard, cement-like substance, and, when the negatives and the positives are charged, the plates are quickly formed into positives and negatives, the positives turning into lead peroxide and the negatives into spongy lead. It can be readily seen that the pasted plate can be developed into cells having considerable more capacity than the plante plate, and we have the pasted plates in commercial use in connection with automobiles. The pasted plate is better adapted to light rates of charge and discharge, and will not stand up under heavy rates of charge and discharge as the plante plate, due to the contraction and expansion of the active material, which results in the breaking down of the electro-chemical contact of the active material to the supporting grid.

About nine or ten years ago, when the storage batteries began to be used to any extent in car lighting, the battery manufacturer had, for some years, been furnishing storage batteries for stationary service, but, unfortunately, the conditions of car lighting are exceedingly hard on the storage battery, due to the constant vibration, the jolting of the cars, and, further, to the inadequate attention that can be given to the individual batteries and cells in an installation of any magnitude. The normal battery used for car-lighting purposes is a 280 ampere hour cell, where 16 or 32 cells are used per car, dependent upon whether the car is to have 30 or 60 volt lamps. There were three principal types of plates offered:

First—The pasted positives and negative plate, which were not found satisfactory for the service, on account of the active material being loosened up in the supporting grid, and dropping to the bottom of the tanks; the life of the plates being everything but satisfactory, and the resultant cost of operation being high.

Second—The positive plate is composed of a grid about 3-15 inch to ¼ inch thick, punched full of holes about ½ inch in diameter. Into these holes is pressed a button of pure lead. This button is made by rolling in a spiral form a corrugated, pure lead ribbon. In through coach and axle dynamo equipments, this type of plate is found to have very short life, and proved to be entirely unsatisfactory for the service. The manufacturer of this plate has kept pace with the development and to-day is furnishing a plante plate similar to the original, with the exception that the supporting grid has been made twice the former thickness, or, practically the thickness of the button, and present experience seems to indicate that this plate is far superior to the original product and will successfully meet car-lighting conditions.

Third—In the original plante battery offered for car lighting service, the positive plate consisted of a pure lead grid, which had a surface developed by means of passing over it a band saw, sawing out grooves about ⅛ inch or 3-16 inch deep, and a little less than 1-16 inch in width. This plate was originally pasted full of active material, which, however, fell out very rapidly, leaving only plante formation. In this condition the life of the plate was good, but the difficulties of developing sufficient surface in this method prevented its successful use, the surface being insufficient to maintain necessary active material for the capacity desired. The plante plate is now used in both negative and positive plates, the surface developed by either spinning out the lead in fine ribs, by means of revolving gang knives, or by cutting and turning up the fine ribs by means of shaper knives, the ribs being from 24 to 30 per inch and about 3-16 inch in depth.

The plante plate was the first plate developed to successfully meet the car lighting conditions, it being capable of maintaining its capacity for a big percentage of its life, and being sufficiently rugged to withstand the vibration and hard knocks met with in car lighting.

Recently a number of plates have been put upon the market which the manufacturer expects to meet the conditions; and, notably among them is a cast plante form positive plate, the plate being about 7-16 inch thick and having cast through it a series of slots less than 1-16 inch in width and about ½ inch long. To date this plate shows indications of being satisfactory for car lighting service. Another type of plate recently put on the market is a cast grid and grill plate, the grid being cast with openings about three inches square made of lead antimony; and a pure lead grill similar to the positive plate mentioned above being burnt into these openings, with sufficient allowance being made for contraction and expansion. This plate is rather new, and it is hard to say what the results of development along this line will bring forth. The above types are most used in car lighting work; but there are, however, numerous plates of unique design placed on the market from time to time, and for which great claims have been made, but which to date have not met their guarantee sufficiently to make them competitors with the plates to win service.

Effect of Tungsten Lamp Improvement.

The recent development of the Tungsten lamp for car lighting purposes, and the development of the serviceable ampere hour meter may make it possible for car lighting engineers to go back to the pasted battery for the reason that:

First—The Tungsten lamp reduces the rate of discharge on a given car to about half the rate with carbon lamps; and the ampere hour meter installed with 100 per cent shunt for discharge and 80 per cent shunt for charge, makes it possible for the electricians at terminals to give batteries the proper charge, tapering charge at completion and cutting off charge without abusing the batteries by heavy overcharge with the resultant gasing and high temperature. Some of the railroads are making trials of the equipment as above mentioned, but time will tell whether or not they will be successful. If the refinements in car lighting will allow the use of pasted batteries, it will be advantageous, both on account of the fact that the pasted batteries can be purchased for less money than the present car lighting types and are 25 to 30 per cent lighter.

In regard to the Tungsten lamp itself, there is no question but that this type of lamp will replace carbon lamps. Its success is mainly due to the development of the so-called hot circuit, this being the method whereby, instead of turning the current completely off from the lamp when lights are not required, the lamp is merely switched from the main batteries to one or two hot circuit cells, merely sufficient current being sent through the lamps to make the filament show faint red at night. This arrangement prevents excessive breakage of Tungsten filament, which is an unfortunate characteristic of the filament when it is cold.

Containing Jars.

One of the greatest developments in car lighting work has been the containing jar. The first batteries were installed in hard rubber jars with loose covers. The jars were rather expensive and in shifting cars there was a continual breakage. Further, the slop of the acid was disastrous to the trays holding the rubber jars and the battery boxes supporting the batteries; also, the corroding of the terminals was excessive. To do away with this trouble, wooden tanks with 4-pound lead lining were developed and installed with loose covers. This development proved to be very discouraging. The slop of the acid rotted the tanks, and the lead linings proceeded to develop sulphated spots between the wood and lead lining, eventually terminating in pin holes, through which the acid was lost. The experience along this line was very expensive to the railroads adopting it. However, the advocates of the lead lining continued developments along this line, and the first improvement was to cover the top of the tank with a full rubber gasket, and secure it with a wooden cover holding it in place with iron straps, it being assumed that the rubber gasket pressed between the top of the lead lining and the wooden cover would sufficiently prevent slopping of acid and corrosion of terminals. This modification was an improvement, but the question of leaky tanks continued, and the railroad people had all

they could do to keep their equipment in service.

From this stage, through a series of rapid developments, the present two-compartment lead lined tank was developed, which has proven entirely satisfactory. The outside of lead tanks themselves is cleaned and covered with a coating of petrolyte; the inside of the wooden compartments is painted with acid-proof paint, and before installing the lead linings sufficient molten paraffine is poured into the wooden trap so that when the lead lining is put in place, the paraffine runs up between the lead lining and the wooden compartment, completely filling this space. The covers are now made of hard rubber, the terminals projecting up through bushings of soft, spongy rubber, the covers being provided with sealing grooves to seal them with sealing compound to the lining. This equipment is now standard on a number of roads, and is proving to be entirely satisfactory, although, in engineering work, there is probably nothing that is not subject to further improvement.

After some discussion of axle generator systems, the writer draws the following conclusions:

The axle dynamo appeals to the car lighting engineer, and, in the writer's opinion, if the equipment can be developed to meet the conditions and operate cheaper than the straight storage system, they will be universally installed. The ideal condition would be to install axle dynamos and batteries on cars, so that they could run from one shopping to another, with very little, if any, attention; that is, about 18 months, and the regulation so perfected that no matter whether the car is in runs where very little lighting is required, or in runs of continual night and lighting service; that the condition would be properly matched.

The advent of the Tungsten lamp and the possible use of pasted batteries will tend to change some of the old theories in connection with axle dynamos. The contention of the axle dynamo manufacturer has been that the installation of an axle dynamo allows the user to run his cars 30 instead of 60 volts, thereby doing away with the initial cost in the maintenance of half a set of batteries. The reduced cost of the present battery and the possible use of the still cheaper pasted type of battery, leaves very little, if any, argument in the above contention. The plan of the car lighting engineers and axle generator people should be the development of a small sized machine, which can be wound for either 30 or 60 volts, with the same mechanical parts. The 30-volt machine with 16 cells of batteries should be used on cars where the lighting needed is not over 15 amperes at 30 volts. On the cars with greater lighting capacity the same machine wound for 60 volts should be used with 32 cells of batteries. The above mentioned 60-volt equipment, in view of the greater cost of the 30-volt machine to meet the greater lighting requirements, will be as economical in operation as the 30-volt equipment, but, on the other hand, will have more standby capacity with less lighting failures. In the meantime the safest course of the car lighting engineer is to operate the straight storage system, until such a time that the axle dynamo is properly developed to meet the conditions.

ELECTRIC TRACTION SECTION
EDITED BY
C. L. DE MURALT

German Electric Locomotives for Canal Towing

A rather unusual type of electric locomotive is illustrated herewith. It was built for a somewhat special service, the hauling freight barges on the canalized portion of the Weser River near Bremen, Germany.

Electric Locomotive for Towing Canal Barges.

On the open portion of the river steam tugs do the hauling. Their normal train consists of 5 barges, of 825 tons capacity each, or a total useful load of 4,125 tons per tug.

The problem of hauling these trains by electricity was not in itself very difficult, but it was complicated somewhat by certain local conditions. There are numerous obstacles along the top of the canal wall,

Locomotive and Train of Barges.

such as machinist's houses near the locks, etc., which made the passage of a normal locomotive practically impossible. Furthermore, on some portions of the line, the edge of the canal wall is the only part of

the right of way that is strong enough to support rails without going to undue expense in strengthening the subgrade.

Thus, the limitations of the problem shaped the design of the locomotive.

The picture plainly shows it to consist of two trucks, joined by an overhead structure which latter is placed high enough above the rails to clear any possible obstructions. The trucks are practically 15 feet apart, which brings them close to the edge of the wall wherever that is necessary. The locomotive is built for a maximum drawbar pull of about 7,000 pounds and a continuous pull of 3,500 pounds. It was desired to have this pull exerted at as nearly constant speed as possible. It was considered advisable to have the motor as nearly fool proof as possible. The three-phase motor was therefore the natural choice. Power is delivered in the shape of three-phase alternating currents at 7,000 volts and 60 cycles per second.

The contact line is well shown in illustration Figure 2. It consists of three copper conductors of about 5/16 inches in diameter each, which lie loose in insulated forks on top of iron poles of special construction.

The locomotive collects its current by means of three rollers which lift the copper wires out of their forks as they pass. The supports are placed about 85 feet apart. The locomotive weighs fully equipped about 13 American tons.

Generation and Distribution of Electric Power and Its Application to Railroads*

F. DARLINGTON

It is the purpose of this paper to discuss the generation and distribution of electric power, with especial reference to its use on railroads for the operation of heavy trains, such as are generally used on steam roads.

In order to fully appreciate the engineering matters and commercial questions that determine the conditions favorable for the generation and application of electric power, the following facts should be kept in mind:

Quantity of power is measured in two ways:

First, by the peak load or the maximum momentary requirement, which determines the required capacity of the generating plant in horsepower or kilowatts.

Second, by the amount of power in horsepower hours or kilowatt hours, which is determined by the average load upon the power plant and the length of time it is maintained.

The ratio between the maximum load and the average load on a power plant is spoken of as the "load factor," and as the term "load factor" is used under different conditions for indicating other ratios, it should be understood that in this paper it denotes the ratio between the average load on the plant and the maximum or peak load that may occur for a short period.

Cost of Power.

The cost of producing power naturally divides itself into two parts. One of these depends on the size of the plant required for the maximum load that it has to carry, and the other on the average output of the plant or the average amount of power produced. The first includes all fixed charges, such as interest on the cost of the plant, taxes, sinking fund, etc., reasonable charge for upkeep of plant and allowance for obsolescence. The second includes nearly all operation expenses, such as station labor, fuel, water, and supplies of all kinds that go into the operation and maintenance of the plant, which are mainly consumed by reason of the operation.

Both fixed and operating expenses of power production are much less per unit generated in very large plants, working at a good load factor, than in small plants, or in plants working at a poor load factor. This is well illustrated by all modern central station electric plants.

In the Engineering Magazine for September, 1909, there is an article by Mr. H. S. Knowlton, discussing the cost of operating labor in electric power plants, in which the ratio of steam power plant, operating labor and power plant capacity is stated from actual results in stations up to 6,000 kilowatts. He indicates that the average operating labor per kilowatt hour output for central stations of 600 kilowatts capacity is about .75c per kilowatt hour, which falls to .30c per kilowatt hour in stations of 6,000 kilowatts capacity. Under normal conditions, this cost of operating labor per kilowatt hour output will fall to something between .10c and .20c per kilowatt hour in large stations, and in very large stations, working at a good load factor, to somewhere about .075c per kilowatt hour, or .066c per electrical horsepower hour, since one kilowatt hour is equivalent to 1 1-3 horsepower hour.

While there are great variations in individual cases, it is reasonable to consider the cost of operating labor per kilowatt hour output of a 50,000 kilowatt steam plant as somewhere in the neighborhood of 15 or 20 per cent of the labor for a 1,000 kilowatt plant.

The matter of power plant efficiency is greatly in favor of large plants as compared with small ones. This is especially true in regard to steam plants, but is also true to a certain extent of hydro-electric and gas engine plants. In modern steam turbine plants working at a good load factor, the fuel economy of a 50,000 kilowatt installation will often be better than the economy of a 1,000 kilowatt plant in about the ratio of 1 to 2 or even 1 to 3. There are some large steam plants working on a thermal efficiency, or an efficiency between the heat units of the fuel supplied and the heat units of electric power output, of 10 or 11 per cent, which is equivalent to about 2¼ to 2½ lbs. of best quality coal per kilowatt hour output, or 1.7 to 1.9 lbs. per electrical horsepower hour. In a 1,000 kilowatt plant the thermal efficiency in practical operation will rarely exceed about 4 per cent, which is equivalent to about 6 lbs. of good coal per kilowatt hour output. There are, of course, a great many things affecting plant efficiency that necessarily make these figures very general. To get exact figures in any specific case it is necessary to enter into many details, such as load factor, type of steam plant, whether engine-driven or turbine-driven, whether condensing or non-condensing, etc., but whatever the other conditions may be, large capacity of a generating plant is one thing that always tends to cheap power production and a good load factor is another.

*An address delivered before the Canadian Railway Club at Montreal, Feb. 7, 1911.

Load Factor on Electric Plants for Heavy Railroads.

Plants generating power for heavy railroad operation generally show a poor load factor. There are several fairly large plants in America that are used exclusively for supplying power to main line railroad trains, and their load factors (ratio of maximum output to average output) are somewhere between 20 and 35 per cent, which means that the average load on the plant is only about ¼ of their capacity. On this basis the fixed charges alone on the cost of steam plants generating electricity for railroad service (interest on investment, taxes, depreciation, etc.) are generally between .4c and .5c per kilowatt hour delivered.

At such poor load factors the operating expenses per kilowatt hour are also very high, and in existing power plants for trunk line railroads the operation and maintenance, exclusive of fuel, comes to about .20c to .30c per kilowatt hour (except where the load is equalized and the peaks supplied by very heavy and costly storage batteries, which modify the results by improving the load factor). Fuel is the other principal operating expense in power production, and in existing railroad plants it amounts to about .11c to .155c per kilowatt hour for each dollar per ton for good coal.

If power stations were much larger than the existing railroad plants above referred to, which are between 10,000 kilowatts and 25,000 kilowatts each, the construction cost per kilowatt capacity would be much less, since very large plants cost less per kilowatt than smaller ones. If a great many locomotives were supplied by a single plant, the load factor might often be doubled, and these two things together might easily reduced the fixed charges per kilowatt hour from .4c to .5c per kilowatt hour to approximately .2c or less per kilowatt hour. Again, because large plants can be operated and maintained more cheaply proportionately than smaller ones, and plants working at a good load factor cost little more for labor and repairs than when working at a poor load factor, the operating labor and repairs of power plants for railroads might be reduced to .10c or .15c per kilowatt hour, as against .20c to .30c from actual experience of railroad plants at poor load factors. Moreover, as the coal consumption per kilowatt hour is very much less in large plants working at good load factors than in smaller ones at poorer load factors, there is a chance for 10 to 20 per cent saving in the item of fuel.

All of the foregoing shows that electric power should, wherever possible, be supplied at a good load factor, which may be secured by serving as many different operations as possible from one large station.

Individual Power Plants.

Each of the existing American installations for trunk line electric operation has its own power plant, which generates electricity for its individual use and for practically nothing else. The load factor on the power plants is poor, excepting in two instances (the N. Y. C. & H. R. R. R. and the Detroit River Tunnel of the Michigan Central R. R.), where it is partially equalized by tremendously costly storage batteries. In each of the cases the electrified section is relatively short, and does not cover what would ordinarily be a complete locomotive run or operating division. In each instance steam locomotives take all or many of the trains to the electrified zone, and, except for the difficulties and danger of tunnel operation, could readily complete the run without the electric service, and at very little extra expense. It is obvious that electric operation on a short section, which breaks up an engine run and substitutes electric motive power for a short distance only, must be a source of extra expense (regardless of the superiority or otherwise, of electric power relative to steam power), since, after a steam locomotive has made the 80 or 90 miles of an ordinary engine run of 100 miles, more or less, for which it is adapted, it will not entail much additional cost to complete the run with the steam locomotive. To install an entirely new motive power system for a few miles of operation must always be disproportionately expensive.

A projected electrification of importance has recently received considerable public notice. It is the electrification of all the steam railroads within the metropolitan district of Boston, upon which subject the principal railroads entering Boston have made reports to a special commission appointed by the Massachusetts Legislature. These reports give estimates of the equipment cost and operating expense for the electrical operation of all steam railroad trains within the metropolitan district; and as the proposed power plants are to be used for railroad work only, they show very poor load factors. Under these conditions, where electric operation is not to replace steam locomotives for an entire locomotive run, but only to take up the work of steam locomotives at or near the metropolitan district lines (irrespective of the end of the usual engine run), the report of the railroad companies that the cost of electrification would be much heavier than the saving in operating would warrant, should seem entirely reasonable.

(To be continued in the July issue.

1,500-VOLT EQUIPMENT FOR PIEDMONT & NORTHERN RAILWAY.

The Piedmont & Northern Railway, a subsidiary company of the Southern Power Company, Charlotte, North Carolina, has ordered from the Westinghouse Electric & Manufacturing Company all the substation and car and locomotive equipment for its 125-mile interurban line, which will be operated with direct current at 1,500 volts.

The aggregate cost of the equipment ordered is approximately $400,000. It includes ten 500 kilowatt motor-generator sets for the substations, twenty-three quadruple 90 horse power car equipments, and fourteen 55 ton electric locomotives, which will be used for hauling freight trains.

This new line, which is now under construction, will connect Charlotte and Kings Mountain, North Carolina, and Spartanburg and Greenwood, South Carolina. It will have some long steep grades, but each of the locomotives is to be of sufficient capacity to haul a train of 800 tons. They will be equipped with four interpole motors geared to the axles.

Electrification of the Broad Street Terminal line of the Pennsylvania Railroad in Philadelphia is contemplated, according to press reports. It is proposed to have all trains drawn by steam locomotives start from the West Philadelphia station where through trains now stop without going into Broad Street. The station at Broad Street will thus become a terminus for a heavy suburban traffic with trains operated chiefly on the multiple unit system.

AN ERROR CORRECTED.

In the abstract of Mr. W. S. Murray's paper on the New Haven electrification, which appeared in these columns last month, the figures on coal consumption of passenger locomotives were credited to Messrs. Stilwell and Putnam. This was incorrect, as these figures were given by Mr. Murray in the discussion upon the paper by the above-mentioned gentlemen, and were the result of his own investigation.

SHOP SECTION
EDITED BY
GEO. W. CRAVENS

Railway Shop Series II.—C. & N.-W. Railway

The principal shops of the Chicago & North-Western Railway Co. are located at West Kinzie St. and Fortieth Ave., Chicago, Ill., and cover an area of approximately three-quarters of a mile in length by one-half of a mile in width. These shops are equipped to do all sorts of locomotive and car repairing and building. Electric power is used for driving about 85 per cent of the machinery.

Practically every make of motor is represented in the equipment, although there are more Westinghouse motors in use than any other kind. All of the current required in these shops is generated in the railway's own power house, continuous current at 110/220 volts on the three wire system being used. The only exception is a small 1100 volt A. C. line running to the freight house.

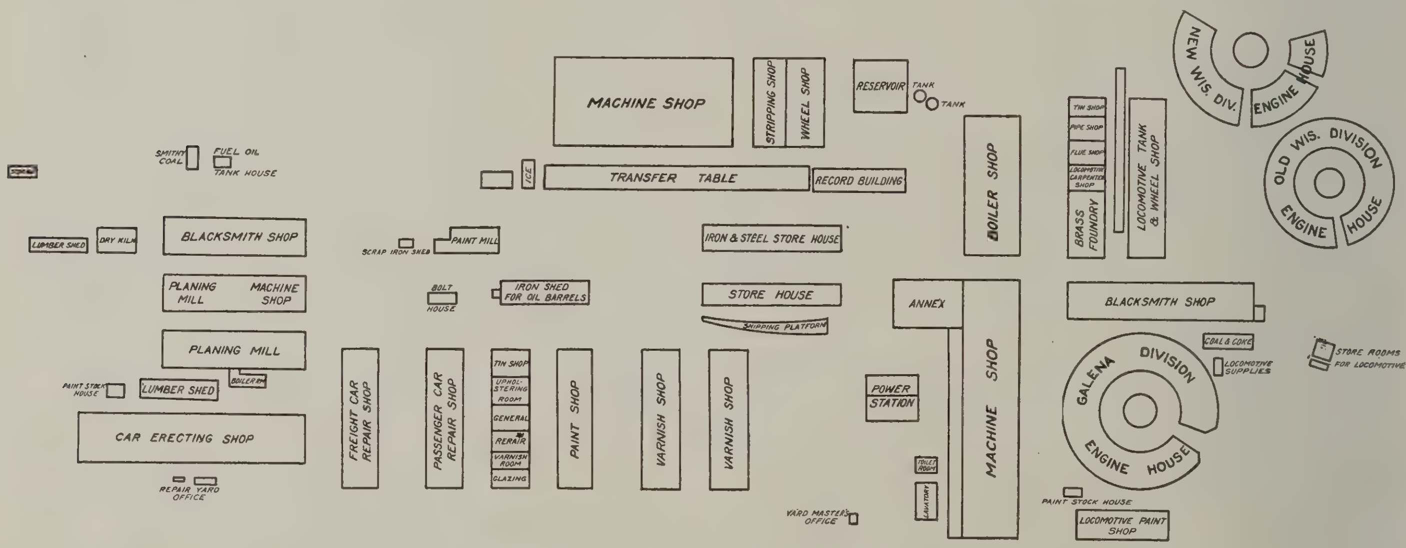
These shops were started about the time of the Chicago fire, and most of the old buildings erected in 1873 and 1875 are still standing and in use. The growth of these shops has been steady and has kept pace with the development of the road.

Power Plant and Distribution System.

The power station is located southeast of the geographical center of the shops and slightly south of the center of gravity of the power load. The building is of brick, as are practically all of the important buildings, and is approximately 110 ft. by 175 ft. in size. It is divided into three sections, the north end being the boiler room, the central section containing the engines, generators pumps, etc., and the newer south section being used largely for storage.

The boiler room contains eight Babcock and Wilcox 250 H. P. water tube boilers, arranged in pairs and equipped with Green grates and stokers. Originally each pair of boilers carried a 66 in. by 100 ft. steel stack, but these have all been superseded by a single brick stack 8 ft. 6 in. in diameter by 180 ft. high. Coal is brought direct to the building in cars and unloaded by hand into a conveyor at the north end of the building. Steel hoppers, overhead in the boiler room, store the coal and chutes are provided to carry it down to the stokers in the usual manner. Ashes are taken out below the grates by means of small cars.

The engine room contains all of the power generating and controlling apparatus. The main generators are 500 K. W., 250 volt, D. C. machines, one being made by the General Electric Co. and the other by the Westinghouse Electric and Mfg. Co. Both of these machines are driven by Allis-Chalmers vertical cross-compound engines of 700 H. P. each. These sets are located along the south side of the engine room, and two smaller sets are directly opposite on the north side. These latter consist of vertical, compound Ball engines of 225 H. P., each of which is direct-coupled to two General Electric 75 K. W. 125 volt D. C. generators. A compensator set is also provided, consisting of two 12½ K. W. 125 volt Westinghouse generators coupled together. The 1100 volt A. C. circuit spoken of is obtained from a motor generator set consisting of a 60 K. W. Warren alternator direct coupled to a Sprague-Lundell 50 H. P. 220 volt motor. A General Electric starter controls this motor.



General Layout of Chicago & North-Western Shops.

The pumps in this power station are as follows:

- One Fraser and Chalmers steam driven cross compound, two stage air compressor delivering 1,500 cu. ft. of free air per minute at a pressure of 90 lbs. per sq. inch.
- One Sullivan Machinery Co. steam driven compound, two stage air compressor delivering 2,450 feet of free air per minute at 90 lbs. pressure.
- Dne Deane hydraulic power pump for operating tools in shops. This pump delivers oil instead of water for this purpose and provides a pressure of 1,600 lbs. per square inch.
- Two Fairbanks-Morse hydraulic service pumps providing the general water supply at 40 lbs. pressure.
- One Fairbanks washout pump for the round houses. Pressure, 120 lbs.
- Two Stillwell-Bierce and Smith-Vail 14 in. by 15 in. by 10 in. boiler feed pumps.

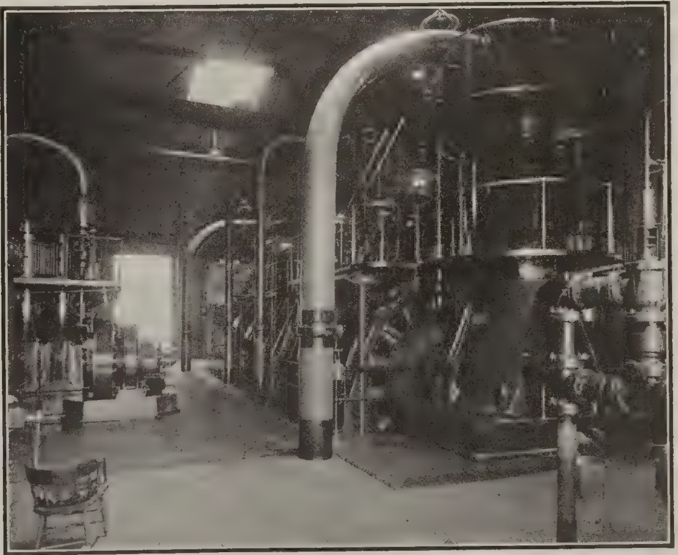
A large panel has been placed in the engine room containing gauges for all of the systems. They include both indicating and recording gauges of various kinds for water, steam, air and oil lines. This panel is near the entrance to boiler room and is entirely separate from the electrical switchboard.

The average load on this station ranges between 2,500 and 3,800 amperes during day working hours and between 500 and 1,000 amperes at night. About 20 per cent of the day load is for lights while nearly all of the night load is for that purpose. With the exception of the line of running to the new locomotive machine shops all of the distribution lines are overhead. One million circular mil "Okonite" cables are used for overhead lines, while the underground line is insulated with varnished cambric and lead covered. No substations are required as the shops are very compactly located and distances are all short.

Chicago Shops of Chicago & North-Western Railway.

The main switchboard is of marble, in two sections, placed one above the other, and is located at the east end of the generating room. The lower section consists of seven panels, six of them controlling the D. C. generators and the center one controlling the compensator set. The generator panels each contain a Weston illuminated dial ammeter, a Sangamo switchboard type recording wattmeter and an I. T. E. circuit breaker in addition to the rheostats and main switches. Two voltmeters are mounted on swinging brackets at the left end of the board. The rear of this board is enclosed by a screen, and behind it are the fire alarm and telephone controlling stations. The Gamewell fire alarm system consists of 15 boxes located throughout the shops, and the automatic telephone system connects with 32 stations.

Interior of Power Plant—Switchboard.



Interior of Power Plant—Showing Engines and Generators.

The upper section of the main switchboard also consists of seven panels, four of which are blank to allow for extensions. Of the others, one is a totalizing panel containing two Sangamo integrating wattmeters, two Bristol recording meters and two Westinghouse graphic meters. The two other panels are the feeder controlling panels, containing the necessary switches for operating 10 feeder circuits. The positive and negative switches are on separate slabs, and a voltmeter is located on a swinging bracket at the left end of the board. The feeders are all carried from the switchboard through iron conduits.

Locomotive Shop.

Strictly speaking, the C. & N.-W. Ry. has no locomotive shop, but rather a series of shops. The main machine shop is a one-story brick building 120 ft. wide by 522 ft. long, built in 1873. It has an annex 100 ft. by 120 ft., built in 1899, and an addition along the west side, built in 1906. A passageway runs down the center of the building, along which two monorail or "walking" cranes travel. These cranes were designed by the engineers of the company and consist of a truck carrying a swiveled upright mast and adjustable boom. The smaller one contains one motor, but the larger one has four motors and is a remarkable piece of apparatus. This will be described in detail at a later time, as it is worthy of special attention because of its value in places where overhead traveling cranes cannot be installed.

On the east side of the main aisle are 24 tracks with pits, extending into the machine shop from the transfer table along the east side of the building. All of these extend to the center aisle, and may be served over about one-half their length by the special cranes above mentioned. Along the west side of the building is the machine tool section containing the following equipment:

TABLE I.

LOCOMOTIVE MACHINE SHOP TOOLS.

No. Name—	Motor. H. P
1—3 ft. 6 in. x 14 ft. planer	25
1—60-in. slotter	40
1—50-in. slotter	35
1—2 ft. 6 in. x 34 ft. planer	35
1—24-in. shaper	10
1—60 in. x 20 ft. planer	35
1—48 in. x 15 ft. planer	25
1—2-in. drill press	3
1—Cylinder boring machine	25
1—42-in. engine lathe	7½
1—25-in. shaper	10
1—Wheel press	15
1—Crank pin boring mill	15
1—36-in. engine lathe	15
1—24-in. emery grinder	7½
1—36-in. emery grinder	7½
1—48 in. x 10 ft. planer	25
1—36-in. x 16 ft. planer	10
2—Large wheel lathes, each	25

Also the following machine tools driven by belts from line shafting:

2—30 in. x 12 ft. planers.	2—24-in. emery grinders.
1—60 in. x 16 ft. planer.	1—25-in. shaper.
3—1-in. drill presses.	2—50-in. boring mills.
1—48 in. x 15 ft. planer.	2—37-in. boring mills.
1—4-spindle bolt turner.	1—Double head drill press
1—18-in. emery grinder.	1—18-in. shaper.
1—6-spindle tapping machi	2—2-in. drill presses.
1—13-in. shaper.	2—½-in. drill presses.
4—Bolt cutters.	2—12-in. slotters.
4—Small drill presses.	1—16-in. slotter.
1—30-in. emery grinder.	3—30 in. x 8 ft. planers.
1—50-in. boring mill.	1—23 in. x 16 ft. planer.
1—Small emery grinder.	2—22-in. lathes.
1—Link grinder.	1—36-in. lathe.
2—36-in. lathes.	1—42-in. lathe.
2—20-in. lathes.	2—Wheel turning lathes.
1—10-in. lathe.	1—40-in. lathe.
2—24-in. lathes.	1—16-in. shaper.
2—32-in. lathes.	1—26-in. lathe.
1—30-in. lathe.	1—24-in. emery wheel.
3—28-in. lathes.	1—17-in. lathe.
1—16-in. lathe.	

The larger machines are driven by individual motors and the line shaft driving the smaller ones is divided into four sections, each of which is driven by a 35 h. p. General Electric motor. The annex at the north end of the locomotive machine shop contains the machines given on the following list, the brass department being located in the galleries of this section. There are 48 motors totaling 783 h. p. in this building.

TABLE II.

LOCOMOTIVE MACHINE SHOP ANNEX TOOLS.

1—96-in. boring mill—35 H. P. motor.
3—21-in. lathes, each—10 H. P. motor.

Following driven from line shafts:

1—96-in. boring mill.
1—88-in. boring mill.
1—30 in. x 5 ft. planer.
1—36 in. x 5 ft. planer.
1—5-spindle drill press.
1—48-in. boring mill.
2—50-in. boring mills.
1—22-in. lathe.
2—2-in. drill presses.
1—8-spindle drill.
1—24 in. x 10 in. milling machine.
1—24-in. emery grinder.
3—32-in. lathes.
1—26-in. lathe.
2—40-in. lathes.
1—24-in. Newton saw.
3—21-in. lathes.
2—24-in. shapers.

Also the following in the Brass Department:

1—20-in. shaper.
3—Small milling machines.
1—24-in. lathe.
4—16-in. lathes.
2—24-in. emery grinders.
8—Automatic screw machines.
1—6-in. lathe.
2—20-in. lathes.
8—18-in. lathes.
1—42-in. grinder.

The boiler shop lies next north of the machine shop and is 120 ft. wide by 300 ft. long. There are 14 tracks entering this building from the transfer on the east. Along the west side of the center aisle are the bending rolls, shears, punches, etc., and an acetylene welding outfit. There are three overhead traveling cranes in this shop, one 25-ton and two 10-ton, one of the 10-ton cranes being over the machine tool section and the others over the main room. One of the line shafts is driven by a 25 h. p. motor and the other by a 15 h. p. motor. At the north end of this shop is located the equalizer for the hydraulic system. There are four motors in the boiler shop, aside from the crane motors, totaling 80 h. p., and the tool equipment is as follows:

TABLE III.

BOILER SHOP MACHINE TOOLS.

1—Sheet roller driven by 25 H. P. motor.

The following belt driven:

1—4-ft. grinder.
1—6-spindle drill press.
1—Single-spindle drill press.
1—¾-in. punch.
1—4-ft. blower.
1—12-in. shear.
2—⅝-in. punches.
1—13-in. shear.
1—18-in. emery wheel.
3—Hydraulic presses.
3—Cranes, motor driven.

The locomotive tank and wheel shop is 80 ft. by 344 ft. and lies east of the boiler shop near the roundhouses. There is a 25-ton overhead crane here and eleven tracks enter the building from the transfer on the west side. The line shaft is driven by a 75 h. p. motor and the total capacity of the 6 motors in the shop is 107 h. p. without the crane motors. The following tools are installed here:

TABLE IV.

TANK SHOP MACHINE TOOLS.

No. Name—	Motor. H. P.
1—8-in. shear	5
1—20-ft. sheet roller	5
1—13-in. shear	5
1—⅝-in. punch	5
1—⅜-in. punch	5

And the following belt driven:

1—18-in. emery wheel.	1—18-in. emery wheel.
1—10-ft. sheet roller.	1—Wheel press.
1—Angle iron cutter.	1—38-in. boring mill.
1—⅝-in. punch.	1—48-in. boring mill.
1—36-in. wheel lathe.	2—32-in. axle lathes.

Two new buildings for locomotive machine shops have recently been erected and will be ready for occupancy soon. These lie northwest of the old machine shops and near the freight yards. The main machine shop is 189 ft. by 362 ft., while the building for the stripping and wheel shops is 189 ft. by 150 ft. These buildings are of brick and steel with large window areas and are up-to-date in every respect. Large machine tools with direct connected motors are being now installed. A separate description of these will be given later.

Freight Car Shops.

One building, 80 ft. by 302 ft., is the only shop used exclusively for freight cars, although the car erecting shop is also used for freight as well as passenger cars. The

latter shop is approximately 100 ft. by 475 ft. in size and lies to the west of the other car shops. The entire group of car shops lies in the western portion of the grounds, six tracks passing through the erecting shop from end to end. Fourteen tracks enter the freight car shop from the transfer on the east side of the building. These latter tracks also extend through the five buildings of the passenger car shops which lie just east of the freight car shops and the transfer just mentioned. The freight car repair shop was built in 1875 and the car erecting shop was built in 1902, both of them being of brick, one story high, with skylights.

The car machine shop is located north of the erecting shop and occupies the east half of a one-story brick building 80 ft. wide by 308 ft. long. Two tracks enter this building from the west and connect with a north and south transfer track through turntables, this latter track going south to the erecting shop and connecting to the tracks running east through the car shops. The following machine tool equipment is provided for this machine shop and three motors totaling 205 h. p. are installed:

TABLE V.

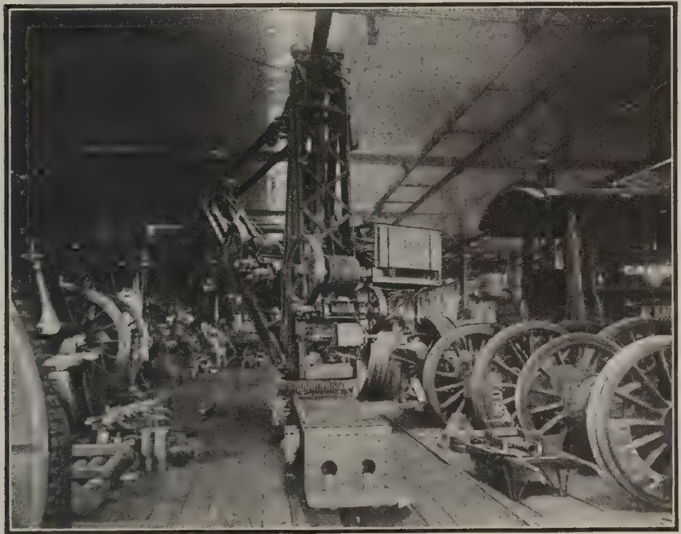
CAR MACHINE SHOP TOOLS.

10—Bolt threading machines.
6—Engine lathes.
10—Drill presses.
9—Axle lathes.
3—Wheel turning lathes.
6—Wheel boring mills.
6—Wheeling boring mills.
3—Wheel presses.

All of the above are operated from line shafting driven by a 35 H. P. and a 90 H. P. motor.

Passenger Car and Paint Shops.

Five buildings are devoted to passenger car building and repairs. These buildings lie along the southern edge of the shops, between the freight car shops just described and the central power station. The repair shop, paint shop and two varnish shops are one story high, and



Locomotive Shop—Special Monorail Crane.

a single two-story building contains the tin, glazing, upholstering and general repair departments, etc.

Fourteen tracks run through all of them except the two-story building, this having three tracks. Two transfers run between the car buildings, one between the freight and passenger repair shops and one between the paint and varnish shops. A third lies east of the second varnish shop.

In addition to various portable tools there are 6 motors totaling 30 h. p. in the passenger car shops for machine tools.

The locomotive paint shop is located just south of the Galena Division roundhouse and east of the main locomotive machine shop. It is a one-story brick building 66 ft. wide by 200 ft. long and was built in 1902.

Blacksmith Shops and Foundry.

There are two blacksmith shops at this plant, one for locomotive work near the east end of the yards, and among the roundhouses, and the other, for car work, located near the west end of the yards and just north of the car shops. The locomotive blacksmith shop, 80 ft. wide by 400 ft. long, and built in 1873, is a one-story brick building. There are 6 steam hammers in this shop in addition to many small tools. Five motors totaling 190 h. p. are provided, a 25 h. p. operating the line shaft and a 50 h. p. driving the main fan. The smith shop for the

Machine Shop.

car department is 80 ft. wide by 308 ft. long and is a one-story building erected in 1875. One 25 h. p. motor here is all that is required. The machine equipment for these shops is as follows:

TABLE VI.

BLACKSMITH SHOP TOOLS.

Locomotive Department.

No.	Name—	Motor. H. P.
1	15-in. shear	35
1	48-in. friction saw	25
1	Large blower	75

The following are belt driven:

1—30-in. lathe.	1—Emery wheel.
1—31-in. lathe.	3—Bull-dozers.
1—Large shear.	1—36-in. grindstone.
1—Forging machine.	1—1-in. drill press.
1—Bolt maker.	3—Spring makers.

The other equipment is:

6—Steam hammers.	12—Oil burning furnaces.
1—Bradley hammer.	25—Forges.

Car Department.

15—Forges.
2—Rivetting machines.
10—Oil burning furnaces.
4—Bolt headers.
4—Forging machines.
5—Bradley hammers.
5—Punches and shears.
1—Bull-dozer.
2—Steam hammers.
2—30-in. blowers.
1—40-in. suction fan—25 H. P. motor.

The only foundry at this plant is for brass castings and occupies a space 80 ft. by 140 ft. in a building just west of the locomotive tank and wheel shop and north of the locomotive blacksmith shop. A 35 h. p. motor is installed here.

Planing Mill.

The planing mill is in two sections, one of them occupying both floors of a building 80 ft. wide by 308 ft. long and the other filling a space 80 ft. wide and 150 ft. long, in the west end of the building previously mentioned as containing the car department machine shop. Two tracks run into each of these buildings, and extra precautions against fire have been taken by installing a complete automatic sprinkler system throughout. These buildings lie north of the large car erecting shop at the west end of the yards and were built in 1875. The machine equipment is as follows:

TABLE VII.
PLANING MILL MACHINERY.

2—Planers and matchers.
2—24-in. circular rip saws.
3—Cut-off saws.
2—Gainers.
2—Vertical 4-spindle drills.
1—End sill tenoner.
1—Double-head surfacer.
1—1-in. band saw.
2—Hollow chisel mortisers.
2—Horizontal 4-spindle drills.
1—Saw Filer.
5—Jointers.
2—Universal wood workers.
2—Double-head shapers.
4—Sticking machines.
2—Wood-turning lathes.

All of the above are in the large mill, which is driven by a steam engine. Scrap is used for fuel and a separate plant is located near mills for this purpose. The small mill contains the following machines:

1—Rip saw.
2—14-in. cut-off saws.
1—36-in. 4-side sill planer and matcher.
2—4-side stickers.
1—Boring mill.

A 50 H. P. motor is used here in addition to the power from the steam engine above mentioned.

Roundhouses and Stores.

There are three roundhouses here, an old one containing 38 stalls used for Wisconsin Division, a new one with 24 stalls for Wisconsin Division and one with 39 stalls for the Galena Division. The latter stands east of the central power station and south of the other two round houses. These buildings are of the usual construction and are fitted with electrically operated turntables. Six motors totaling 105 h. p. are installed in the roundhouses.

Numerous storage buildings are located throughout the shop yards, the most prominent being the iron and steel storehouse, 58 ft. by 300 ft., general storehouse, 50 ft. by 300 ft., record building (fireproof), and the two large coal pockets at the east end of the grounds. A two-story chemical and testing laboratory stands near the power station and the paint mill is near the car shops. The C. & N.-W. Ry. makes all of its own paint, both red and yellow. One 90 h. p. motor is used to drive this mill, which contains one crusher and six paint grinders.

In the same building with the brass foundry are the tin shop, pipe shop, flue shop and locomotive carpenter shop. One 35 h. p. motor is used in the carpenter shop and two motors with a combined capacity of 45 h. p. are installed in the flue shop.

Shop and Yard Lighting.

The lighting system is the result of gradual development. At present three kinds of lamps are in use, carbon incandescent, enclosed arc and Cooper-Hewitt mercury vapor lamps. The accompanying table gives the number and location of the various types of lamps, and it will be seen that good lighting is provided. Many of the machine tools have individual lights and large numbers of portable lamps with flexible leaders are installed. The only Cooper-Hewitt lamps are 25 in the locomotive department machine shop, and 7 in the boiler shop. Yard lighting is accomplished by 200 incandescent lamps and 45 enclosed arc lamps, hung from brackets or from poles and span wires at various places about the grounds .

Miscellaneous.

A noticeable feature of these yards and shops is the special care taken in providing against and for fighting fire. Sprinklers are installed wherever practicable, numerous hydrants are placed about the yards and hose racks are located in the shops. A fire engine roadway runs through the grounds, passing all important shops.

Fire alarm stations are placed in all of the large buildings and many small ones and at intervals about the yards.

WHERE THE POWER GOES

	Lighting			Motors									
Dept.	Incandescent Lamps	Enclosed Arc Lamps	Cooper-Hewitt Lamps	Machine		Crane		Transfer		Turntable		Elevator	
				No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.	No.	H.P.
Loco. Mch. Shop	237	74	25	46	733	2	50	1	25				
Boiler Shop	8	18	7	4	80	3	140						
Blacksmith	76	5		5	190								
Tank Shop	9	9		6	107	1	90	1	7½				
Carpenter Shop	3	5		1	35								
Brass Found.	15	5		1	35								
Flue Shop	13	8		2	45								
Power Sta.	49	6		2	65								
Laboratory	35	2		1	5								
Galena R. H.	147	2		2	40					1	10		
Wis. R. H.	202			4	65					1	-10		
Tank & Paint	32	4		1	18								
Yards	200	45											
Car Shops	1100	-		6	30			4	40			1	10
Car Mch. Shop	79	6		3	205								
Blacksmith	43			1	25								
Paint Mill	25			1	95								
Wreck Crane						2	22						
Lift. Magnet				1	15								
Storehouses	266			2	12	3	11					1	10
Oil House	12			1	2								
Totals	2551	189	32	90	1802	11	313	6	72½	2	20	2	20

Another good feature is the provision for safeguarding employees from accident. Guards are placed about the most dangerous moving apparatus and large viaducts have been built over the railroad tracks south of the plant. The grounds are well kept and equipment and supplies of all sorts are arranged in good order and at convenient places.

The writer desires to extend his thanks to Mr. George Murray, chief electrician of these shops, for his courtesy in furnishing much of the information here given, and to various others who made this description possible.

Railway Telephony*

GREGORY BROWN

(Continued from the May Number)

Listening In.

The second requirement in a railway telephone system is a means whereby any number of stations can simultaneously listen in. In giving a value to a certain quality and volume of transmission it is said to equal a certain number of miles of cable. This means that the number of miles stated is such that when standard instruments are used for this distance over No. 19 gauge telephone cable of 0.06 microfarads capacity per mile, the value of transmission will be the same. It is considered that

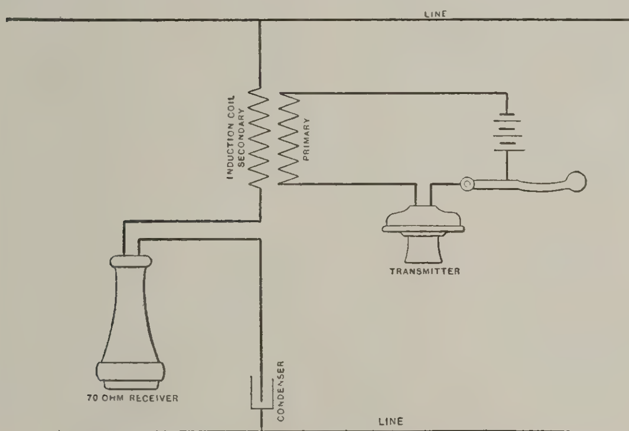


Fig. 7.—Early Form of Sub-Station Circuit.

the commercial limit of good transmission is 30 cable-miles. This value can be equated in terms of any other kind of circuit. One mile-cable loss is equivalent to the loss sustained in 16 miles of No. 9 B. & S. copper, and as this is the standard size of wire used on despatching circuits, it will be seen that the line may be 480 miles long before the so-called commercial limit is reached. This is considerably longer than any of the circuits in use, there being but few over 250 miles in length. There is, therefore, a surplus of transmission available which can be taken advantage of in arranging circuits to per-

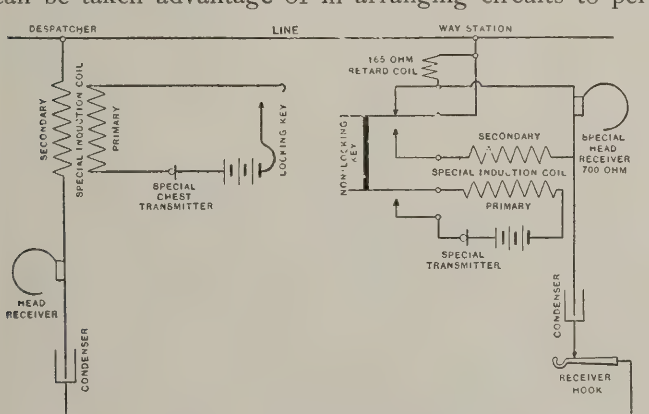


Fig. 8.—A Circuit Later Developed.

mit several operators to listen in simultaneously. The loss occasioned by the selector bridges is almost negligible, the impedance to talking frequencies of the ordinary selector being about 90,000 ohms. This value is such that the loss sustained when forty selectors are across the line is only one mile of cable.

The first form of substation talking circuit used on train wires was the standard local battery circuit, which is schematically shown in Fig. 7. It will be seen that during conversation, the condenser, receiver and secondary of the induction coil are in series. The resistance of the secondary of the coil used was 20 ohms, and of the receiver 70 ohms, a two-microfarad condenser being used in series. The total impedance of this bridge to talking current is approximately 600 ohms, about 300 ohms of which are active for receiving purposes. It is obvious that when a number of these sets are bridged across the line at once, the joint impedance of the parallel paths is very low and the transmission correspondingly difficult between widely separated stations.

The first step towards overcoming this difficulty was to raise the impedance of the talking bridge by the use of a different induction coil, wound with a low primary and a high impedance secondary. This bettered matters somewhat as the higher resistance bridges produced a more even distribution of the talking current from the despatcher's office, and would give better outgoing transmission from the substations. Although the despatcher's voice currents were undoubtedly better distributed among the bridges with this arrangement, still, due to the fact that the bulk of the impedance in the bridges was in the

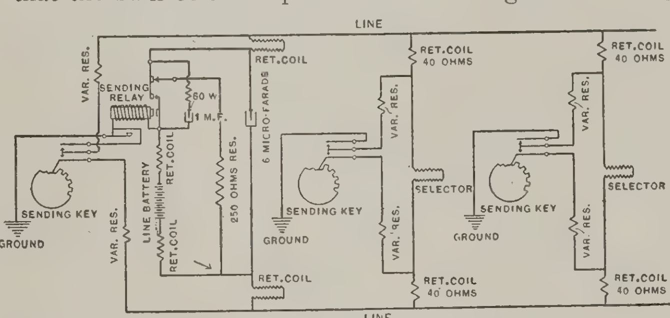


Fig. 9.—Intercommunicating Circuit.

secondary of the coil, the receiver having a resistance of but 70 ohms, the transmission gain was very slight.

The next obvious step would be to maintain the high impedance in the talking bridge but put as much of this impedance as possible in the receiver. If this were done, however, the high impedance receiver in series with the secondary of the induction coil would reduce the outgoing transmission from the substation to an objectionable extent. It was then determined that the best results, both for receiving and transmitting, would be obtained by installing a switching arrangement at the substation so that when the switch was in one position the circuit was in the best possible condition for receiving, and when in the other position was in the best possible condition for transmitting. The circuit developed is shown in Fig. 8, the circuit to the left representing the despatcher's station and to the right the way station.

Message Circuits.

The requirements of message circuits are similar except that selective signaling must be capable of being performed by any operator on the line, and it must be possible to signal all the operators at the same instant.

The telephone has been in use for message work on a number of wires in which all the calling is done by one operator, thereby differing somewhat from telegraph operation. Circuits, however, have recently been developed for inter-communicating work which give satis-

*From a paper before the A. I. E. E.

factory service. Probably the one having the widest margin of operation was developed in connection with the step-by-step selector and is shown in Fig. 9.

The condensers and retardation coils at the despatcher's end, for reducing the noise of sending, are arranged practically as in the standard key, so connected that its operation will place impulses on the line from ground through the center of the resistance, over both sides of the line, through the point A, thence through the battery and sending relay to ground. The operation of this relay places current impulses on the line and operates the selectors at the various stations, the selector used being the standard type used on train wires. Modifications of this circuit arrangement are in use for this purpose but the difficulty that has heretofore been encountered has been that with a grounded relay, the line leaks are liable to be sufficient to either operate the relay or hold it in its operated position

The glass insulators on the pole line along the right of way of a railway are constantly subjected to the smoke and soot from the locomotives. This causes the insulators to become permanently coated with soot and when wet weather sets in, the leaks to ground on railroad lines probably average considerably higher than in commercial practice. The circuit shown was designed to neutralize as much as possible the effects of line leakage in so far as it affected operation. It will be noted that when

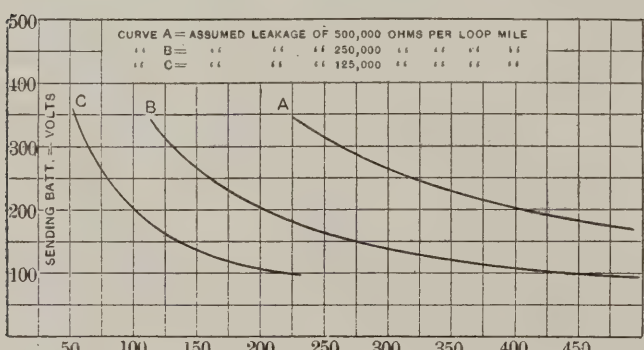


Fig. 10.—Battery Voltage—Line Length Curves for Various Leakages.

any station is sending, current flows from ground of that station over the upper line wire as shown in the figure, to a normally closed contact of the relay, through this contact to the point A on the lower line wire, and then through battery and relay to ground. The contact arrangement is such that the making of the normally open contact cuts off the current from the upper line wire and doubles the resistance for grounded current, thereby cutting the current through the relay in half. The relay being in its operated position, this current is sufficient to hold it. The first effect of line leaks would be to hold the ground relay closed when it was operated. The arrangement shown largely overcomes this tendency.

The taper resistances used in connection with the key at the substation are arranged so as to give the grounded relay the same current from any substation. The curves shown in Fig. 10, show the margins of operation of this system for various lengths of line and operating voltages. For an average line of 130 miles and 160 volts, the line leaks can be as low as 125,000 ohms per mile, without interfering with operation. This is equivalent to about 960 ohms ground leak, which is a value that would seldom be met with in practice.

Block Circuits.

For block wires no new features are required. Many roads are using existing telegraph wires between blocks for ground telephone circuit. If a satisfactory loud-speaking receiver could be produced, it would undoubtedly be very generally used for blocking purposes, as it would do away with the necessity for a signaling device. Some receivers of this sort have been developed and are now being tried out.

In addition to the service performed by the telephone on railroads, as has been described in this paper, it has facilitated railroad business in several other ways. Telephones are used very extensively at sidings. These telephones are generally connected with the despatcher's wire and train crews can immediately get in touch with the despatcher, and a great amount of time can be saved. There has been put on the market a semaphore type of signal in the base of which is mounted a telephone and selector equipment. In case the despatcher wants to stop a train and call the conductor to the telephone, he can do so by operating the selector which throws the signal.

Portable telephones have also come into pretty general use. On some roads, every train carries a portable telephone and a line pole. The line pole is jointed for convenience in carrying and can be quickly assembled for use. It is equipped with two metallic hooks at its upper end which the conductor can connect with the despatcher's wires on the pole line and thereby get into communication with him.

RAILWAY TELEGRAPH SUPERINTENDENTS' ASSOCIATION CONVENTION POSTPONED.

The annual convention of the Association of Railway Telegraph Superintendents will be held in Boston, Mass., at the Hotel Brunswick June 26-30 instead of June 19-24, as previously announced. The change has been made at the request of several members of the association who found the later dates more convenient.

The following papers have been announced by the committee in charge of the program:

"Development of Telephones for Train Dispatching and Other Railway Work," by Mr. G. K. Heyer, of New York.

"Co-operation Between Railway People and the Commercial Companies," by Mr. W. P. Cline, Supt. Telegraph, Atlantic Coast Line R. R., Wilmington, N. C.

"Economy of the Telephone in Railway Service," M. E. Launbranch, Chicago, Ill.

"Here Are Some Hints," W. J. Camp, electrical engineer, Canadian Pacific Railway, Montreal.

There will also be a report from the Committee on High Tension Crossings, of which Mr. G. A. Cellar, superintendent of telegraph of the Pennsylvania Lines West of Pittsburg, is chairman, and from other regular committees of the association.

Inquiries in regard to the convention should be addressed to Mr. P. W. Drew, Room 306, 112 W. Adams St., Chicago, Ill., who is secretary of the association.

THE C., B. & Q. EXTENDS ITS TELEPHONE TRAIN DISPATCHING SYSTEM.

The Chicago, Burlington & Quincy Railroad, which was one of the first to use telephones for train dispatching, has just placed an order with the Western Electric Company for twenty-seven of their new selectors and associated telephone equipment for use on its St. Joseph Division.

This new circuit will be installed between Kansas City and Napier, Mo., a distance of 96 miles, and the dispatcher will be located at St. Joseph. For use with the telephones on this division a supply of the new Western Electric moisture-proof cords have been ordered.

When this equipment is installed the C., B. & Q. will be operating over 2,700 miles of track by the telephone.

Interior Conduits

Supplementary to the paper and discussion on "Conduit in Railway Service," which appears in another place in this issue, are the following descriptions of some of the leading kinds of interior conduits.

GALVANITE.

Galvanite, manufactured by the American Conduit Company, of Pittsburg, is a mild steel tube from which all foreign matter and irregularities have been removed. The outside protection against corrosion is a pure metallic zinc coating deposited by the galvanizing process. The galvanizing process consists of immersing the steel to be galvanized in a bath containing salts of zinc. On the passage of an electric current through this bath, pure zinc is deposited on the steel. The interior of the conduit is enameled. It is claimed that this enamel is especially tough and elastic and is not affected by extremes of heat or cold. Zinc coated pipe bond well with concrete and thus acts as a reenforcement in this type of construction.

GREENFIELD FLEXIBLE STEEL CONDUIT.

This conduit, manufactured by the Sprague Electric Works, is constructed of rolled strips of steel, so formed that the inner and outer walls are both smooth. These strips, which are first coated with a protective layer of zinc by the galvanizing process, are wound spirally upon each other in such manner as to interlock their concave surfaces, and present their convex surfaces both interior and exterior.

This conduit can be bent in any direction without destroying its circular cross section. Joints are made by clamps instead of by threading. Its adaptability is especially advantageous in wiring old buildings. This conduit is also manufactured with wires enclosed, either one or two conductors being furnished.

SHERARDUCT.

Sherarduct, made by the National Metal Moulding Company, of Pittsburg, Pa., is so called from the fact that the protective layer of zinc is deposited by what is known as the "sherardizing process." The process consists of placing the iron or steel to be coated in an air tight iron drum and packing it with very finely

"National" Metal Moulding.

divided zinc particles. The drum is then placed in a furnace and "tumbled," while the temperature is gradually brought up to 800 degrees F. The drum is then removed and allowed to cool gradually.

This heating causes the zinc to form an alloy with the iron at the point of contact, and to be deposited in a thin layer over the surface of the alloy. It has the additional beneficial effect of annealing the metal so that it is easier to bend and less likely to crack or break. The zinc layer is deposited inside and out, and it is claimed for the alloy that its resistance to corrosive action is much greater than that of zinc alone.

After the sherardizing process, a transparent enamel is applied to the interior, making the surface smooth.

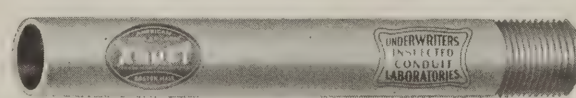
Sherarduct.

An oil finish is then given both inside and out, and the interior is soap-stoned.

This company also manufactures a metal moulding of handsome appearance, which is protected from corrosion by the sherardizing process.

X-DUCT.

The distinctive feature of this conduit, which is made by the American Circular Loom Company, of Boston, Mass., is the coating of copper which is applied to the outside of the pipe under the zinc. This coat is applied to the clean steel and covers every particle of the surface with a very thin layer. Upon the copper is de-



X-Duct.

posited a layer of zinc. It is claimed that the bond between copper and steel and between zinc and copper is better than that between steel and zinc, and that for this reason the zinc protective coating is less likely to flake off. The interior of the pipe is lined with enamel as in other conduits.

VICTOR-BALATA AND TEXTILE BELTING COMPANY.

The new plant of the Victor-Barata and Textile Belting Company at Easton, Pa., was opened for active operation on May first. This belting has, for a number of years, been imported into America from Germany by the New York Leather Belting Company. The new company is a combination of German and American interests. Mr. Vollrath, secretary and manager of the new plant, is a grandson of C. Vollrath, the founder of the German company.

The services of the foreman and superintendent of the German plant were secured to instruct the American workmen in the processes of manufacture.

The new plant contains about 30,000 square feet of floor space used for manufacturing purposes. The buildings are of concrete and steel throughout, and the ten acre tract on which they are located provides ample room for future expansion. The special machinery required was imported from Germany.

Balata belting is so called from the fact that the balata gum is used to impregnate a duck foundation. This gum comes from the boela tree and is obtained by tapping or bleeding. The sap is coagulated by boiling or drying in the sun. Balata gum is very strong and tough, impervious to moisture, and very slow to deteriorate. Unlike rubber or gutta percha, it cannot be vulcanized.

Balata gum has a high friction power, which does not diminish with wear. It is claimed for Victor-Balata belting that the thorough impregnation of the duck gives it a friction which stays the same regardless of wear and that with it slippage is reduced to a minimum.

A special Balata belting for car lighting work will be manufactured at this factory.

General News and Personal Mention

ANNUAL CONVENTION OF A. I. E. E.

The annual convention of the American Institute of Electrical Engineers will be held in Chicago, June 26 to 30, inclusive, at the recently completed Hotel Sherman. Several papers of especial interest to railway electrical men will be presented at this convention including "Multiplex Telephony and Telegraphy by means of Electric Waves Guided by Wires," by Major G. O. Squier; "Electrification Analyzed and its Application to Trunk Line Railroads," by W. S. Murray; "Telegraph Transmission," by F. F. Fowle; "The Costs of Railway Electrification," by B. F. Wood, and "Electric Storage Batteries," by Bruce Ford.

Other papers to be presented are:

"Economical Design of Direct Current Magnets," by R. Wikander; "Catenary Span Calculations," by W. L. R. Robertson; "Currents in Inductors of Induction Motors," by H. Weichsel; "Electrolysis in Reinforced Concrete," by C. E. Magnusson; "Induction Motor Design," by T. Hoock; "The High Efficiency Suspension Insulators," by A. O. Austin; "The Di-electric Strength of Air," by J. B. Whitehead; "The Cost of Transformer Losses," by R. W. Atkinson and C. E. Stone; "Induction Motor for Single-Phase Traction," by E. F. W. Alexanderson; "Magnetic Properties of Iron at 200,000 Cycles," by E. F. W. Alexanderson; "The Characteristics of Isolated Plants," by P. R. Moses; "Elevator Control," by T. E. Barnum.

Owing to its rapidly increasing business, the Detroit branch of the Willard Storage Battery Company has been obliged to find larger quarters which have been secured at 1191 Woodward Avenue, Detroit, Michigan, where a salesroom and fully equipped battery repair department will be ready for business after May 15. This branch is in charge of Mr. Max G. Hilman, well known in Detroit automobile circles.

Manual for Engineers.—The Sangamo Electric Company, Springfield, Illinois, have issued a Pocket Data Book which contains a great deal of valuable engineering information for mechanical and electrical engineers. The reference tables are conveniently arranged and the Manual should prove of much value to the recipients.

The Illinois Central has now 72 steel passenger cars under construction. All will be electric lighted throughout. When these are put in service solid steel electric lighted trains will be run over the Illinois Central tracks between Chicago and Jacksonville, Chicago and St. Louis and Chicago and New Orleans.

Burton W. Mudge & Company, railroad supplies, Chicago, have announced the election of Thomas H. Garland as a director of the company. Mr. Garland is the inventor of the Garland car ventilator, which is manufactured and sold exclusively by Mudge & Company.

The National Metal Moulding Company, Pittsburgh, has recently distributed a wall sheet showing National fittings of all kinds. The sheet makes it handy for reference and makes a handsome ornament on any wall.

THE LARGEST REINFORCED FACTORY IN PHILADELPHIA.

It has just been announced that the Electric Storage Battery Co., at 19th St. and Allegheny Ave., has closed a contract with John G. Brown, designer and builder, Witherspoon Bldg., for the design and construction of a new reinforced concrete building which will be the largest manufacturing building of this type in the city.

This addition to its present plant will be a building approximately 300 ft. long by 115 ft. wide, six stories high, with a one-story triangular extension about 80 ft. by 120 ft. These buildings will be constructed by the patented system of mushroom reinforced concrete construction and will be designed to meet the particular demands of this company.

The demand for storage batteries of this company's manufacture has increased to such an extent that it has been necessary to provide additional manufacturing facilities at once.

The Electric Storage Battery Co. has recently closed contracts with many of the large electric lighting companies for enormous "Exide" storage batteries for emergency service, and these large orders, together with the enormous demand recently made upon the company for the "Exide" and the new "Ironclad-Exide" electric vehicle batteries have greatly increased the business of the company.

These new buildings will be of the most up-to-date design, strictly fireproof, will be provided with the most modern machinery and the best facilities for the convenience of its employees. The construction of these buildings is to start at once, to be completed during the fall, and will give employment to a large additional force of workmen.

A contract to ventilate all of the first-class Harriman Line cars with Jandus fans has recently been awarded the Adams-Bagnall Electric Company. This includes the following systems: Union Pacific, Southern Pacific, Oregon Short Line, Oregon Railroad & Navigation Co., S. P., L. A. & S. L., Western Pacific R. R., Texas Pacific R. R., Central of Georgia, Atlantic & Pacific Steamship Lines. This contract includes business for all of the steamships of the Atlantic and Pacific steamship companies which are controlled by the Harriman Company.

The Gould Coupler Company has recently issued Bulletin 11A, describing the Gould Simplex System of electric car lighting. The bulletin is printed in brown and black on fine paper and bound in an embossed cover on which the well-known Gould trademark, a winged wheel, shows up to good advantage. Descriptions of the generator, regulators, storage batteries and suspension are included, with a wiring diagram.

The suit of the U. S. Light & Heating Company vs. J. B. M. Electric Company, Gould Coupler Co. and John W. Jepson, involving patent applications Serial No. 404,271 and Serial No. 404,272 in the Western District of New York before Judge Hazel, has been decided in favor of the U. S. Light & Heating Co.

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WITH WHICH IS INCORPORATED THE

Electric Trunk Line Age

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

The June Conventions.

CONSIDERABLE progress in the direction of standardization was made at the June conventions of the Association of Railway Electrical Engineers, the Master Car Builders' Association, the Master Mechanics' Association and the Association of Railway Telegraph Superintendents.

The train lighting standards as adopted by the M. C. B. Association agree in all essential points with those adopted by the A. R. E. E. The two organizations are working in harmony and there has been shown on the part of the Master Car Builders a disposition to let the electrical engineers settle their own problems. The work of the electrical departments is distinct from, though in the present organization necessarily subordinate to, that of the mechanical departments. A change of motive power from steam to electricity will reverse their positions or rather merge them together.

The A. I. E. E. convention was important for the concrete evidence of the practicability of electric trunk line traction which it brought out.

Electrification Progress in the First Half of 1911.

THE first half of the year 1911 has not shown the progress in electrification that was expected. Although there has been much talk and speculation on the subject very little has actually been done. The only definite extension started has been that on the New Haven. The only work completed has been the Southern Pacific electrification at Oakland. The Chicago Commission has not as yet, even organized its engineering staff. No further action has been taken at Boston. Rumors and rumors of rumors have been plentiful, but of actual progress there has been very little.

There is, of course, good reason why this is so. Practically every railroad in the country has been forced by the rate regulation to economize in every possible way. The expense of operation and maintenance has been cut to the absolute minimum. Even so a reduction has been necessary in the dividend rates of some of the more prominent roads and in general there has been a shrinkage of values in railway securities. This makes it difficult not to say impossible for the railways to secure the money for improvements such as electrification, however desirous they may be of making these improvements. It is, we believe, generally conceded that all large railways stand ready to make every improvement possible. What is halting electrification today is not so much the physical as the financial difficulties involved.

While the progress in complete electrification has been slight, such partial steps as the adoption of the gasoline-electric car for handling branch line and local traffic have been taken by many roads. There are undoubtedly sections of railroad where this unit is more satisfactory and more economical than any complete electricfication would be. The denser the traffic over a railroad, the greater become the advantages of complete electrical operation. The reverse is true of the gasolin electric car. It shows to greatest advantage in regions of lightest traffic. There is no competition between the two. They are not two solutions of the same problem. There is room for both. On account of the much smaller investment required the gasoline-electric car seems at present to be making the more rapid progress.

While the progress of electrification in general is being held up by reasons more economic than engineering, a steady improvement in engineering technique can be noticed. The experience on already existing railroads, as placed at the disposal of the engineering fraternity in such papers as those of Mr. W. S. Murray and Mr. B. F. Wood before the American Institute of Electrical Engineers, will be invaluable in the design and operation of the electrified railroads of the future. Estimates and plans which, in the past, have been based largely upon theory, can, in the future, be based upon data obtained from actual operation. And when the time does come, it is not unreasonable to suppose that electrification will spread over the country with a speed like that of the telephone for train dispatching, which, in the last four years, has supplanted the telegraph on over 20 per cent of the railway mileage of the United States.

ASSOCIATION NEWS.

This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.

COMMITTEE REPORTS.

A Communication From the President.

To the members of the committees of the association, Gentlemen:

While the reports submitted at the Washington convention of the progress of the various committees of the association were generally satisfactory and showed that progress was being made, there were several lamentable exceptions. I wish to call your attention at this time to the necessity for early and thorough action by these committees. I think what most impressed those of us who attended the recent convention of the Master Car Builders' Association at Atlantic City was the completeness of the committee reports and the relatively small amount of time required for discussion on them. In most cases the reports were adopted practically as read, with the result that a large amount of business was transacted in a short time. The reason is that these reports were very carefully written and as presented required few changes.

The business of an association such as ours is to bring about standardization of railway equipment and practice. Experience has shown that this can best be accomplished by delegating to committees the work of determining what standards shall be adopted for particular features. Committee reports should be definite, specific and well-thought ont. They should be treated with respect by the association as a whole and not altered without good reason. Thus the work of the association, as of any large body, is largely the work of its committees. If the work of the committees is good the association is a success; if it is poor, the association is bound to be a failure.

It is of inestimable advantage to us that the reports should be presented at the annual convention in printed form, as was done at the last convention in the Railway Electrical Engineer. Having these reports in printed form gives each member a chance to consider them at his leisure and to formulate any suggestions or changes he may care to make. To insure their publication in ample time all reports must be in the hands of the secretary by September 1. Now it may seem like a good while till September 1 but many difficulties will arise and there is no time like the present to get busy. If reports can be sent in before September 1, so much the better. Very truly yours,

J. R. SLOAN.

ANNUAL CONVENTION OF A. I. E. E.

The annual convention of the American Institute of Electrical Engineers was held in Chicago, June 26-30. A very large attendance from all over the country, and the great present interest of many of the papers presented made the meeting a very successful one.

From the point of view of the railway men the session of Wednesday morning, in charge of the railway committee, was the most interesting of the week.

Three papers were presented at this session: "Induction Machines for Heavy Single Phase Motor Service," by E. F. W. Alexanderson; "Electrical Operation of the West Jersey and Seashore Railroad," by B. F. Wood; and "An Analysis of Railway Electrification," by W. S. Murray. An abstract of the last mentioned paper, which was also presented at Toronto in April, has already appeared in these columns.

Mr. Alexanderson's paper discusses the possibility of operating polyphase motors from a single phase circuit. The scheme is to use an induction motor as a phase converter. Two terminals of the induction motor are connected to the single phase line while all three are connected to the driving motors. The advantage of using polyphase motors for driving is that greater starting torque can be secured. It is thought that the additional weight of the phase converter is more than balanced by the improvement in efficiency of the driving motors. Three phase current can be secured without the use of three phase transformers, which weigh about one-half more than single phase transformers of the same capacity.

Mr. Wood's paper is especially caluable for the concrete and definite data it contains on costs, both of construction and operation. The West Jersey & Seashore is a direct current, over running third rail system, using 675 volts. The aggregate costs of construction on this electrification were: Power stations, $994,900; transmission line, $241,500; substations, $491,500; third rail, $557,636; cars, $1,135,900. Unit costs given were: Power station cost per kilowatt, $110; substations, buildings and equipment, cost per kilowatt, $28.90; and the following costs per mile: transmission lines, $3,485; third rail, $4,235; overhead trolley, $4,120; track bonding, $684. The complete cost of the motor cars used averaged $12,214 each. In addition to these figures detailed costs of operation and an analysis of the service rendered by the electrical equipment were included. These will be published in the August issue of this journal.

The discussion on the papers of Mr. Wood and Mr. Murray was very spirited. Mr. Murray's frank advocacy of the single phase system brought out an opposition to it almost as frank from various members who believe in direct current.

Mr. Frank J. Sprague recalled to those present that in his opening address as president of the Institute in 1892 he had prophesied that the development of electric traction would first be confined to street railways, later spreading to connecting lines between these systems, then to interurban service and finally to heavy railroad service on trunk lines. This prophesy has been fulfilled in the 19 years since, the last stage of progress having just begun. He criticised single phase operation and disagreed with the opinion expressed by Mr. Murray that storage batteries have no place in railway electrification, saying that the line of progress is through greater centralization of power stations with corresponding lowering of unit costs.

E. B. Katte highly commended the paper of Mr. Wood but regretted the lack of comparative data between steam and electric operation. He called attention to the fact that according to the figures in Mr. Murray's paper the cost of maintenance of a single-phase trolley was six times as large as that of a third-rail. Also that the detention of trains from motive power causes in a given unit of time was 28 minutes on the direct-current system as compared with 1,920 minutes on the single-phase system. Mr. Katte said that the first cost of a direct-current system wa $51,000 per mile while that of a single-phase system was $71,000 per mile.

L. C. Fritch, chief engineer of the Chicago & Great Western Railway, said railroad men are making a mistake in warding off electrification which is inevitable, and that much of the money spent in line revision, tunneling, etc., might more advantageously have been put into electrification. He said that a complete revision of the yards and terminals of Chicago is necessary and that for electrification of these, an overhead trolley system is the only feasible one.

A. R. E. E. Semi-Annual Convention at Washington

The semi-annual convention of the Association of Railway Electrical Engineers was held at Washington, D. C., June 16 and 17. The meetings were held in rooms of the new Washington Terminal Station. The total attendance was about 75, larger than at any previous semi-annual meeting. The eastern roads were especially well represented, but there was a liberal delegation from the central west. President J. R. Sloan presided at all meetings. The work of the convention consisted chiefly of the discussion of preliminary reports offered by the various committees, with a view to putting these reports in such shape that they will meet with general approval and can be acted upon quickly at the annual convention in Chicago, Nov. 6-10.

The Friday morning session was devoted to the consideration of the report of the sub-committee on Lamp Specifications, which was presented by J. L. Minnick (Pennsylvania). This report, which is a set of specifications for the purchase of incandescent lamps, is given in full on a succeeding page. The report met with some criticism from representatives of the lamp manufacturers, but except in a few minor details was considered very fair both to the purchaser and the manufacturer. It was referred back to the committee with suggestions for changes and will be presented for adoption at the annual convention.

Friday afternoon was given over to the consideration of the recommendations of the Train Lighting Committee of the Master Car Builders' Association. J. H. Davis (B. & O.) said that he thought a flat rate should be charged for the use of electric lighting equipment on a car by a foreign road. He thought that this charge should be 75c per day, regardless of the number of cells in the battery. D. J. Cartwright (Lehigh Valley) said that his road pays the Pullman Company $3.00 per thousand miles for the use of the electric lighting equipment on its cars, and that he thought the proposed rate of 75c per day entirely reasonable. A motion was carried that it was the sense of the meeting that 75c per day be adopted as the charge to foreign roads for the use of electric car lighting equipment.

In regard to the question of the location of fuses in a car lighting equipment there was some discussion as to whether fuses should be placed on the switchboard inside the car or at the battery terminals. F. R. Frost (Santa Fe) said that his road had wired a car with the fuses on the switchboard. A short circuit was formed between the battery and the board, the battery connectors were burned off and the car set on fire. J. C. Causland (Penna. Lines West) said he considered it good practice to have two fuses at the battery terminals. This was agreed to by President Sloan. Finally it was moved and carried that the recommendation to the M. C. B. Committee provide for the use of two fuses of not to exceed 150 amperes capacity, placed at the battery terminals.

Group on the Steps of the Washington Terminal.

The report to be made by the Committee on Illumination was outlined by C. R. Gilman, chairman. It will deal with the physiological as well as the engineering aspect of illumination, and will contain recommendations for standard practice in yard lighting, roundhouse lighting, and shop lighting, as well as in car lighting.

The report of the Committee on Accounts and Reports was outlined by F. R. Frost, chairman. The Standard Report Sheet worked out by the committee will group all items of car lighting expense under the following heads: (1) Maintenance and Operation; (2) Fixed Charges; (3) Installation of Equipment. The question of how much depreciation to allow on storage batteries was discussed at some length. The figure of 20 per cent was suggested, but no decision was reached.

Saturday morning was given over to a tour of inspection of the U. S. navy yards and gun shops. Arrangements for this, as for all other features of the convention, were made by N. E. Van Buskirk, of the Washington Terminal Company, to whom much credit is due for the success of the meeting. A large number of those present went to Atlantic City.

Specifications for the Purchase of Incandescent Lamps*

General Requirements.

1. *Facilities for Inspection at Factory.* Manufacturers shall furnish suitable and satisfactory facilities for inspecting, initial testing, shipment, and such other assistance as will enable the inspector to inspect and test lamps in accordance with these specifications.

2. *Test and Inspection.* All lamps purchased shall be subject to inspection and test for physical defects and initial rating. Only such lamps as are specifically mentioned in the several schedules for different classes of lamps will be subject to life test. Should it become desirable to correct the several schedules on account of changes in the art, or to make additions on account of the purchase in quantity of lamps not specifically mentioned, new limits which have been agreed to in writing by the purchaser and the manufacturer, may be substituted or added hereto.

3. *Samples.* To show construction, bidders shall submit two samples of each kind, size, and type of lamp they propose to furnish. All lamps shall conform to the samples submitted, in shape and size of bulb, mechanical construction and type of filament, and no departure from the sample lamps will be permitted without written authority from the purchaser.

Definitions and Standards.

4. *Unit of Candle Power.* The unit of candle power shall be the International Unit as maintained by the Bureau of Standards, Washington, D. C.

5. *Photometric Measure.* The basis of comparison for all lamps shall be the mean spherical candle power. The nominal or rated candle power to which reference is made in these specifications shall be the mean horizontal candle power based on reduction factors given in the several schedules for different classes of lamps. All readings for mean horizontal candle power shall be made with lamps rotating at a speed sufficient to overcome flickering.

6. *Determination of Reduction Factors.* For lamps having filaments giving a different ratio of mean spherical to mean horizontal candle power, the mean horizontal candle power measurements shall be corrected by reduction factors determined by the Bureau of Standards, Washington, D. C.

7. *"Lot" of Lamp.* The word "lot," when used in these specifications shall mean: (1) Single package of lamps of the same kind, size, and type, when the package contains one hundred or more lamps. (2) A group of packages containing, as nearly as possible, one hundred lamps of the same kind, size and type, when each package contains less than one hundred lamps.

Method of Inspection and Test.

8. *Place of Inspection and Initial Test.* Inspection for physical defects and tests for initial values of candle power and watts, shall be at the place of manufacture.

9. *Notification of Laboratory.* Manufacturers shall notify the laboratory when lamps are ready for inspection, and shall await the arrival of the inspector before shipment of lamps.

10. *Inspection for Physical Defects.* The inspector shall examine for physical defects ten (10) per cent of each lot of lamps offered, the inspection covering not less than ten (10) lamps.

11. *Rejection on Account of Physical Defects.* Should more than fifteen (15) per cent of the number of lamps from each lot examined in accordance with Paragraph No. 10 show any physical defects incompatible with good workmanship, good lighting service, or with any clause of these specifications, the lot of lamp represented by this examination will be rejected.

12. *Test for Initial Rating.* The inspector shall examine for initial rating ten (10) per cent of each lot of lamps that have passed the inspection for physical defects, the inspection covering not less than ten (10) lamps.

13. *Rejection on Account of Initial Rating.* The lamps selected with paragraph No. 12 shall be tested at rated top voltage, ampere, or candle power, as shown in their respective schedules. The failure of more than fifteen (15) per cent of the lamps so tested to come within the limits prescribed in their respective schedules, shall be sufficient cause for the rejection of the lot represented by this examination.

14. *Samples for Life Candle Power Test.* From each lot of lamps which have passed the inspection for physical defects and tests for initial rating, two (2) per cent or the nearest number of whole lamps, and in no case less than two lamps, which approximate most closely to the average of the lamps examined, may be selected for use in the determination of the life and candle power performance, and shipped to the laboratory.

15. *Sealing of Packages.* All packages of accepted lamps shall be marked for identification and sealed by the inspector, and packages must not be shipped until seal is applied.

Physical Characteristics.

16. *Physical Requirements.* The lamps shall be well made and free from all defects as herein specified, and such other defects as in the judgment of the inspector will render the lamps unfit for service.

17. *Bulbs.* Unless otherwise specified, clear lamps shall be furnished. All bulbs shall conform to the dimensions given in these specifications and shall be uniform in shape, clear, clean, and free from flaws or blemishes, and, in the case of tipped lamps, tips shall not be long or blackened.

18. *Bases.* Unless otherwise specified, all lamps shall be furnished with Standard Edison Screw Bases. The shells of the base shall be made of good quality brass, firmly and accurately fitted to the bulb, and all bases shall be impervious to moisture. When bases have extended skirts, same shall be insulated from the shell.

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*Proposed at the Washington Convention.

19. *Filaments.* The filaments of all lamps shall be symmetrically placed in the center of the bulb, and shall be uniform and free from imperfections, spots and discolorations.

20. *Leading-in Wires.* Leading-in wires shall be fused in the glass with the joints between the copper and platinum wires bedded well within the glass, must be straight, well separated, and securely soldered to the base and cap without excess of solder. The threads on the base must be free from solder.

21. *Vacuum.* The test shall indicate a good vacuum when lamps are tested on an induction coil.

22. *Marking.* One or more printed labels, showing rating and manufacturer's name, or trade mark, shall be placed on the bulb near the base of the lamp. Trade names, trade marks, other devices shall not be etched, painted or or marked on the glass beyond the base.

Electrical Characteristics.

23. *Check for Initial Rating.* On receipt at the laboratory of the lamps selected for life candle power performance in accordance with paragraph No. 14, they will be checked for initial rating and subjected to further tests as follows:

24. *Life and Candle Power Maintenance.* For the determination of the average test life of any lot of lamps, the lamps selected as described in paragraph No. 14 shall be tested for candle power performance at the voltage or watts per candle efficiency given in the several schedules.

25. *Test Life.* The average test life obtained in this test shall not be less than the values given in the several schedules under the heading "Life Performance."

26. *Determination of Average Candle Power.* The average candle power during life of any lot of lamps shall not be less than ninety-one (91) per cent of initial candle power. In computing the results of tests of a lot of lamps, the average candle power during life shall be taken as the arithmetical mean of the values for the individual lamps of the lot tested.

27. *Voltages and Test Life.* Variations of voltage during the test described in paragraph No. 23 shall not exceed one half (½) per cent above and one-half (½) per cent below the test voltage. The test life of lamps will be the hours obtained when the candle power has fallen to eighty (80) per cent of the initial value.

28. *Return of Rejected Lamps.* The failure of the lamps on life test shall cause the rejection of the lot represented by the test samples, and in the event of such rejection, the lamps, if shipped will be returned to the manufacturer, who will be required to pay return freight charges.

29. *Report of Tests.* Target and life diagram of rejected lamps will be mailed promptly to the manufacturer upon completion of each test. Samples of rejected lamps shall be preserved at the laboratory for one month from date of test report. In case of dissatisfaction with the results of tests, manufacturers shall make claim for a hearing within that time, and a failure to raise a question within one month from date of test shall be construed as evidence of satisfaction with the tests, the samples will be disposed of, and no claim for a hearing will be considered.

30. *Voltage Rating.* All lamps ordered and furnished in accordance with these specifications shall be rated and tested at top voltage.

THOSE WHO REGISTERED.

Active Members.

J. Andreucetti, C. & N. W. Railway.
L. S. Billew, B. & O. R. R.
R. W. Brodmann, Long Island Railroad.
J. D. Brown, B. & O. R. R.
C. J. Causland, Penna. R. R.
G. B. Colegrove, Illinois Central R. R.
R. C. Curtis, B. & O. R. R.
J. H. Davis, B. & O. R. R.
F. R. Frost, A. T. & S. F. R. R.
C. R. Gilman, C. M. & St. P. R. R.
J. L. Hays, B. & O. R. R.
C. W. Hunt, Atlantic Coast Line R. R.
Wm. Keim, N. Y. C. & H. R. R. R.
W. Kershaw, Penna. R. R.
L. B. Knight, Boston & Albany R. R.
H. C. Mawhinney, Penn. R. R.
A. McGary, New York Central & H. R. R.
J. L. Minnick, Penna. R. R.
J. L. Parker, Atlantic Coast Line.
D. B. Pastorius, Penna. R. R.
Chas. E. Singer, B. & O., C. T. R. R.
J. R. Sloan, Penna. R. R.
J. C. Snyder, Penna. R. R.
R. J. Spears, B. & O. R. R.
Chas. R. Sugg, Atlantic Coast Line.
D. G. Thwaites, Penna. R. R.
E. C. Van Buskirk, Washington Terminal Co.
F. H. Wright, New York Central & H. R. R. R.
Frank Zimkowski, N. Y., N. H. & H. R. R.

Associate Members.

Azel Ames, Kerite Ins. Wire & Cable Co.
F. L. Baxter, General Electric Co.
W. F. Bauer, U. S. Light & Heating Co.
R. S. Carrick, Tipless Lamp Co.
W. G. Davis, U. S. Light & Heating Co.
C. W. Dunlop, Safety Car Heating & Lighting Co.
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H. H. Smith, Diehl Mfg. Co.
N. G. Stark, Oneida Steel Pulley Co.
G. H. Stickney, General Electric Co.
A. J. Sweet, Holophane Co.
B. L. Winchell, Kerite Ins. Wire & Cable Co.
F. J. White, Okonite Company.

Report of the M. C. B. Committee on Train Lighting

The Committee on Train Lighting of the Master Car Builders' Association for the year 1910-11 consisted of T. R. Cook (Pennsylvania), chairman; E. A. Benson (Pullman Co.), Carl Brandt (L. S. & M. S.), Ward Barnum (L. & N.), and J. H. Davis (B. & O.). The last two named are well-known members of the Association of Railway Electrical Engineers. This committee reported on June 21 at the annual convention of the M. C. B. Association, at Atlantic City. The substance of the report is as follows:

The committee sent out a circular of inquiry asking for recommendations as to any changes, additions or corrections in the recommended practice on train lighting and any other points which the members desired the committee to take action on. It received quite a number of replies to this inquiry and changed its suggestions as to recommended practices given in the report of 1910 to read as follows:

1. That each electrically lighted car be provided with a notice giving the following information that this notice shall be posted in the electric locker.

Type of Generator.
Type of Regulator.
Type of Lamps.
Voltage of System.
Voltage of Lamps.
Number of cells of storage battery.
Normal charging rate (at charging receptacle).
Size of train wire, No. — B. & S. Gauge.
Number of train wires (2 or 3).
Capacity in amperes of generator.
Setting of axle generator.
Current output—amp.
Automatic switch—volts.
Zero charge relay—volts.
Lamp regulator—volts.
Amperes—full light.
Diameter of axle pulley. (Outside.)
Diameter of axle bushing. (Outside.)
Diameter of axle bushing. (Inside.)
Diameter of generator pulley. (Outside.)
Diagram of connections showing location, type and ampere capacity of fuses.

2. That where train line connectors are used, Gibbs' No. 3-G train line connector be used, with connections to the battery, dynamo and jumper as shown on Fig. 1. If only two wires are used, they shall be connected to the two outside terminals and the female connector on each end of car shall be stenciled "Not for use on head-end system."

3. That batteries shall be connected up with the positive to the right, facing the car, as shown on Fig. 1.

4. That where double compartment tanks are used, the connections and arrangement of battery terminals are to be as shown on Fig. 2.

5. That each electrically lighted car shall be provided with two charging receptacles, with swivel supports installed one on each side of the car, the outside angular ring to be the positive.

6. That each electrically lighted car be provided with two 150-ampere fuses, close-connected to each battery terminal; the fuses to be arranged and placed in a cast-iron box.

7. That each electrically lighted car shall be provided, on the switchboard in the car, with a switch, a fused switch, fuses or terminals. The switches, fuses or terminals to protect and completely disconnect the following parts: Train line (where train line is used), battery, axle dynamo (where axle dynamo is used. The axle dynamo switch or fuses to control the positive, negative and field of the dynamo). Each of the above switches, fuses or terminals is to be plainly stenciled, designating the part controlled, the positive terminal to be on the right side facing board.

8. Where a main lamp switch is used or where fuses controlling all lamps are used, they shall be so stenciled in plain letters.

9. That all fuses on cars shall be National Electric Code fuses.

10. That where axle dynamos are used, negative, positive and dynamo field shall be fused as close as possible to the dynamo and prior to the leads either entering the conduits or being secured to the bottom of the car. The above fuses to be used for emergency service only and are to be at least 100 per cent above the capacity of the fuses on the switchboards protecting the same leads.

11. The following voltages should be used:
   60 volts (nominal) for straight storage, head end and axle dynamo systems.
   30 volts (nominal) for straight storage and axle dynamo system.

12. That the batteries shall be preferably installed in double compartment tanks.

13. That battery boxes shall have a vent provided in each door.

14. That when facing the end of the truck on which axle generator is mounted, the pulley or sprocket shall be on the right-hand side.

15. That the rules of fire underwriters shall cover all car wiring.

16. That all wiring under car to the switchboard shall be run in conduits.

17. That a straight pulley seat be provided for the axle pulley. That if a bushing or sleeve be used it must be secured to the axle independent of the pulley. Bushing to have an external diameter of 7½ in. and to be 8½ in. long, turned straight. That the pulley hub have a uniform internal diameter of 7½ in., the length of the hub to be 6½ in., the face of the pulley to be 9 in. or wider if flangeless, and 8 in. if flanged. That the generator pulley be flanged, crowned and perforated, and have an 8-in. face.

The following changes have been made in the 1910 exhibits to conform to the recommendations of 1911:

Exhibits E and F have been changed so that the fuse box will accommodate an N. E. C. fuse. On the floor plan in Exhibit E the fuse box has been changed to a location along the end of the battery box.

Exhibit H has been changed to show the Gould positive plate the same dimensions as the Willard positive plate.

Exhibit H has been changed in that the length of the negative bridge has been changed from 10 3-16 in. to 9¾ in., also added on Exhibit H recommended dimensions for the National battery.

On Exhibit I, the detail of chest handle, a lip has been added at the top and projects into the wood tank.

Exhibit H has been changed in that the crown of the lead lining is specified as three to four per cent antimony lead instead of pure lead.

On Exhibit G the method of applying lead lining has been changed to read as follows: "Size lead tank with one coat of chrysolite, then with petrolite and then insert in wooden tank which has been filled to a depth of 2 in. with a mixture of paraffin and petrolite, having the melting point 150 deg. F.

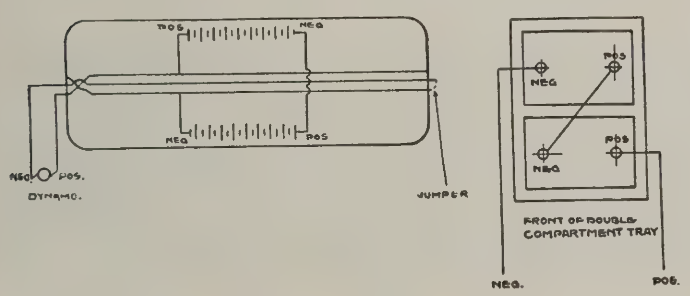
On Exhibit G the abbreviation S. B., indicating Single Braid wire for cross section, omitted; unbraided wire to be used.

Item 31 on Exhibit G covering No. 6 flexible rubber-covered wire changed to show solid wire.

Exhibit K has been changed to show recommended design of vent for battery door.

In connection with Master Car Builders' Rules covering interchange of equipment, your committee suggests that the paragraph at the bottom of page 103 reading:

"On electrically lighted cars a battery depreciation



Figs. 1 and 2—Wiring and Battery Arrangement.

charge of 75 cents per day shall be made," be changed to read as follows:

"On electrically lighted cars, furnished to foreign roads, where no agreement is made, the following charge shall be made per day for use of batteries:

	Depreciation.	Current.	Total.
32 cells	46 cents	29 cents	75 cents
16 cells	23 cents	14 cents	37 cents

Discussion on Train Lighting and Equipment.

G. W. Wildin (N. Y., N. H. & H.): There are a number of recommendations made in that report as to certain special devices, and I would like to inquire if they are patented.

D. F. Crawford (Penna.): It is my understanding that none of the patents are still in existence on those devices.

C. A. Schroyer (C. & N. W.): We have with us this morning D. J. Cartwright, of the Lehigh Valley. He is an electrical engineer and he is also the chairman of the committee on standards of the Association of Electrical Engineers, and I move that he be extended the privileges of the floor for five minutes.

(Mr. Cartwright was given the floor.)

Mr. Cartwright: Before making any remarks on the subject under consideration I wish to state the interests I represent and the reason for my appearing before you to-day. As an individual I represent the Lehigh Valley; I also represent the Association of Railway Electrical Engineers. At a recent meeting of our Association the present report of your committee was thoroughly discussed and I am here to present for your consideration the wishes of the Association of Railway Electrical Engineers, primarily formed for the purpose of standardizing as far as possible the electrical equipment on cars. Fully realizing the importance of the subject, I hope you will bear with me for a few moments in the presentation of the subject which will be submitted to you for your consideration. I take this opportunity to thank your committee on train lighting for their hearty co-operation in embodying in their report several recommendations which have been made by our Association. We do, however, take certain exceptions to a few of these recommendations, as follows:

Sec. 1. Should be changed to include additional information not shown.

Sec. 2. The first line, after the word "used," it was suggested that there should be inserted the words "they shall be interchangeable with."

Sec. 5. After the word "car" in the first line insert the words "equip with battery boxes."

There is no necessity of putting a charging plug on an electrically lighted car that has no battery boxes in it.

Sec. 6. Should read: That each electrically lighted car be provided with two 150-ampere fuses close connected to positive and negative terminals of batteries at battery box, before wires enter conduit leading to distributing board in car. The fuses to be arranged and placed in a strong metal box, substantially as shown on Exhibit F, and installed on car as shown on Exhibit E.

Sec. 7. Omit the word "completely" in the fourth line. Also omit the second item. We have found several instances where porters on the cars have pulled the battery switch instead of the light switch. The result is that all the lamps in the car have been burned out, due to the excessive voltage generated.

The sixth line should read as follows: The axle dynamo switch or fuses to control the positive armature and positive field of the dynamo.

We had considerable discussion on Sec. 10. We wish to eliminate all fuses that we can from a car, consistent with safety. It might be practicable to put a few in your armature, but do not put any in your field or both sides of your armature circuit.

Sec. 11 should read as follows: The following voltages should be used:

For head end or straight storage, 64 volts (nominal).

For axle dynamo systems, 32 volts (nominal).

You will notice that we have omitted the recommendation for 30 volts for the straight storage system. On the second part we have omitted straight storage. It was not considered practicable to operate straight storage on 30 volts.

There is one typographical error which has crept into Sec. 17. In the seventh line the figure "7" should be inserted instead of the figure "8," as the dimensions for the face of the generator pulley.

At a meeting of the members of the Association of Railway Electrical Engineers, held in Washington on June 16, 1911, it was voted that the recommendations of your committee regarding interchange of electric lighted car should read as follows: On electrically lighted cars, furnished to foreign roads, where no agreement is made, a charge of 75 cents per car per day shall be made for the use of the electric lighting equipment.

If any of the suggestions or recommendations that I have made are out of order, I would ask you to excuse my presumption, but accept the recommendations of the Association of Railway Electrical Engineers just the same.

(The President resumed the chair.)

Mr. Wildin: I would like to know whether the

committee in formulating this report took into consideration the fact that some roads are being electrified, and that the charging of the batteries on the car will be taken care of while the cars are on the electric zone? I notice that the gentleman who has just spoken, Mr. Cartwright, recommends a 30-volt system where axle light is used. I would say that you must use axle light for the time being, but it is presumed that in the future the dynamo will be removed and the batteries will be charged while the cars are on the electric zone, and in that case 30 volts is very low.

Mr. Cartwright: If the axle light equipment is removed from the car, then you are not confined to 30 volts.

Mr. Wildin: But I understand you to assume that you were going to have 30 volts.

Mr. Cartwright: Not necessarily.

Mr. Wildin: Then you will have to put in something else.

Mr. Cartwright: We will go to 60 volts.

Mr. Wildin: Then what is the use of throwing a battery away?

Mr. Cartwright: When you go to 60 volts you add a battery.

Mr. Wildin: We are going to put a motor generator set in the electric locomotive and charge the cars while on the electric zone. We are going to have 60 volts and I do not like the recommendation of a 30-volt system where axle light is used.

(The report was accepted and referred to letter ballot.)

M. K. Barnum (I. C.): It seems to me that in referring this report to letter ballot the members would have to vote on it as a whole and not in detail.

The Secretary: That will be arranged.

C. A. Seley (R. I.): In referring the report to the members for letter ballot I would suggest that the recommendations of the Association of Railway Electrical Engineers, which have been voiced here by Mr. Cartwright, be put in form so that our members can consider them in casting their ballots.

Mr. Schroyer: If that is a motion, I second it.

(The motion was carried.)

London, Brighton & South Coast Railway Electrification

An English Suburban Electric System

In common with many other steam railways entering London, the London, Brighton & South Coast Railway suffered heavily from the competition of the ever-increasing electric tramways.

Quite naturally electrification suggested itself as a possible remedy, and in 1903 Mr. Philip Dawson, who had been studying for some considerable time the question of railway electrification, was instructed to report on the advisability of electrifying first of all the section known as the South London line, between Victoria and London Bridge via Peckham Rye, which had been most seriously hurt since the introduction of electric traction on the tramways of the London County Council.

The question was investigated from the financial as well as from the engineering side, and due regard was had to the possibility of extensions in case electric traction proved successful.

It was considered that electrification of the suburban system would enable such a frequent, accelerated and convenient service to be established, as to make it certain that all passengers traveling three to four miles and more would prefer, even at higher fares, to use the railway instead of the tramway. Electric railways enable passengers to travel at twice or three times the speed attainable on tramways, and with certain knowledge of the time it will take to arrive at destination. On cold or wet days the convenience of waiting rooms and sheltered platforms, and the certainty of being able to get into the next train, was also considered a great attraction as compared with waiting in the streets.

That these conclusions were entirely correct is clearly proved by the following interesting figures which relate to the traffic from and to Peckham Rye on the South London line:

PASSENGER TRAFFIC AT PECKHAM RYE STATION (SOUTH LONDON LINE).

Year ending—	Numbers	Remarks
Dec. 31, 1902	1,213,281	Before opening of London County Council Tramways.
Nov. 30, 1909	526,373	Last year of steam trains.
Nov. 30, 1910	1,051,263	First year of electric trains.

As a result of the investigation the report recom-

London, Brighton & South Coast Electrification—Showing Structural Supports for Overhead Contact Line.

London line, which was accordingly carried out. Contracts were signed in 1906. The first experimental mended as a first step the electrification of the South electric train was run on the 17th of January, 1909.

and the whole line was operated electrically for public service on the 1st of December of the same year.

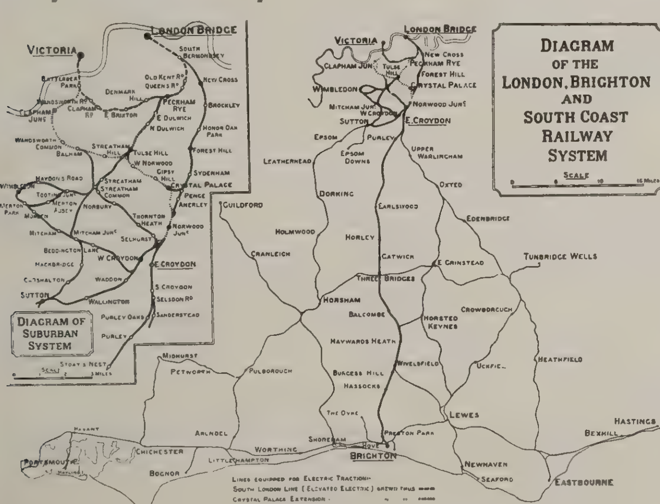
The report had pointed out that electrification of the South London line would soon enable the directors to judge for themselves as to the advisability of further extensions. Expectations have apparently been met in this respect, as may be judged from the fact that the directors have already sanctioned extensions more than twice the size of the original line.

Extent of Electrification.

The section originally electrified, from Victoria to London Bridge, is 8.7 miles in length and has nine

London, Brighton & South Coast Electrification—Four Tracks near Wandsworth Common.

intermediate stations, which gives an average distance of 4,590 feet between stations. The shortest distance between any two stations is between Old Kent Road and Queens Road, which is 1,386 feet. A train very rarely runs either way without at least one additional



Map Showing London, Brighton & South Coast Electrification.

stop due to signals. On this basis the running time allowed is 24 minutes, including stops, which gives trains about two minutes in hand to make up lost time.

Five platform tracks are operated electrically at the Victoria terminus and six at London Bridge. Two running tracks are electrified between Victoria and Peckham Rye and three between the latter station and London Bridge. The total length of track, including sidings, equipped for electric operation on the South London line amounts to 20½ miles.

The extensions now being completed comprise the line from Peckham Rye Junction to West Norwood and the line from Battersea Park to Selhurst via Crystal Palace, a total of 41½ additional miles.

System Adopted.

As regards choice of system Mr. Dawson stated that it was not his intention unduly to accentuate the advantages of one particular system as compared with others and he expressed his regrets that "a battle of the systems" ever arose. He considers that the electrification of any portion of a railway system is purely a financial and an engineering question, and must be solved on its merits alone. Our readers will recognize that these are precisely the views which we have consistently put forward all along.

In deciding which system would prove the most satisfactory for the L., B. and S. C. railway from all points of view, the question of possible early electrification as far as Brighton was not lost sight of, nor the possibility of attracting the London and Portsmouth service via Brighton. The latter coulo electrically be run in the same or even less time via Brighton than at present by steam over the ten mile shorter line via Horsham.

Electric traction can be worked economically, and the interest paid on the capital involved in electrification, only when the trains are sufficiently frequent, and the more frequent the trains the more economical the operation.

If all the above services are taken into consideration, the total number of trains is 72 per day in each direction. It would thus not be unreasonable to contemplate the running of trains at intervals of 12 to 15 minutes for 18 to 20 hours per day.

The distance from London Bridge to Brighton is roughly 50 miles. It was not considered that such a distance could be economically covered by means of the standard 600-volt direct-current system.

Normal trains on the South London line consist of two motor coaches and one trailer car, and weigh 138 tons complete. Trains to be used on the extensions will weigh 148 tons. For such light trains the three-phase system was not considered desirable.

Thus the choice fell on the single-phase alternating-current system with 6,000 volts in the overhead contact line and operated at a frequency of 25 cycles per second. The system installed has handled the traffic admirably.

Feeding and Distributing System.

Power is taken from the London Electric Supply Corporation's power station at Deptford. By means of feeder cables it is delivered to a centrally located main switch cabin, where the current is metered for payment by a duplicate set of meters.

Sets of underground distribution and booster cables carry the current all along the line.

These cables are of the two-conductor, concentric type. The inner conductor is carefully insulated and connected from time to time through switches to the overhead contact line. The outer conductor is bonded to each rail length of the track and thus serves as the return portion of the electric circuit. No bonds are provided between the rails themselves. The drop of pressure in the return circuit is kept within 20 volts.

A five-conductor testing and telephone cable is run the whole length of the line and enters every switch cabin.

Overhead Construction.

The overhead system is arranged in sections, so that a complete section exists between each station and the next. The up and down tracks are also entirely separate, except at terminals where this would

have involved too great a complication. The whole equipment is planned in such a way that it will form an integral part of the entire L., B. & S. C. system when the latter is completely electrified.

Without a doubt, one of the most difficult parts of the electrification of any railway is the design and erection of the overhead equipment. It is well known that considerable trouble was experienced with this portion of the work on certain American railways.

In designing his overhead contact line Mr. Dawson had two main considerations always in mind:

First. It is obviously necessary that the passage of the collector along the conductor should be as smooth as possible. The contact wire must therefore be, as far as possible, parallel to the track, must contain no hard points against which the collector bow will knock, and the suspension must be a flexible one.

Second. The insulators, being the weakest part of the construction, should be as few and as massive as possible. Their factor of safety, from both an electrical and a mechanical point of view, should be very high.

The equipment as actually installed is well shown on some of the illustrations. It is of the double-catenary type, two catenary supporting wires being hung over the contact wire. Dropper wires connect the catenary and the contact wires at intervals of about 10 feet.

The catenary cables are stranded galvanized steel cables and they are not continuous. Each is adjustable at both ends of every span by means of turnbuckles. The sag is so calculated that adjoining catenaries entirely balance each other, so that the structures have to support only the dead weight of the line.

Droppers exceeding 2 feet 6 inches in length are linked. These links are observed to lift slightly as the bow passes beneath them. At the termini chains are used instead of linked droppers to take the jar occasioned by changing the bows.

The contact wire is of copper, circular in section, ½ inch in diameter, and with two sharp grooves into which the clips at the ends of the dropper wires are clamped.

The insulators are of a special corrugated spool type, permanently fitted with a steel tube inside in such a way as to equalize the strain. Nothing but porcelain is used for insulation and great care is used so as to submit it to compression only.

At the terminal stations the height of contact line above rail level was fixed by the Board of Trade at 19 feet 9 inches, which gives 6 feet 6 inches above the highest portion of any coach. Along the line the height was taken at 16 feet, and the lowest wire is 13 feet 9 inches above rail level, making a total variation of 6 feet in the height of the conductor to be dealt with under ordinary running conditions by the collector bows.

It is very interesting to note that this line equipment was designed at the same time the New York, New Haven & Hartford line was being designed and before the latter had been put into practical operation. The South London line has been run over since January, 1909, and gave satisfaction from the very start. In the new construction the original designs have been maintained.

In our next issue we expect to have something to say on the rolling stock and on working results.

Generation and Distribution of Electric Power and Its Application to Railroads

F. DARLINGTON

(Continued from the June issue.)

It is clearly the view of the officials of the N. Y., N. H. & H. R. R. that breaking up a train run to change from steam to electric power, and vice versa, is too expensive a method of operation. This is indicated in their report to the Massachusetts Legislative Commission, in which they say:

"It therefore seems quite safe to conclude that no general substitution of electric for steam traction should be made unless the substitution is complete, including passenger and freight operation, and yard switching in addition, and also that, in making such substitution, the operation should be extended to include the full length of run or engine district, in order to avoid the uneconomical subdivision of the present 'trains run,' together with the added expense and delays incident to intermediate engine transfer stations."

Much valuable practical experience in the cost of heavy trunk line operation by electric power has been gained from American railroads, but it is manifestly unreasonable to expect them to show economy of operation and pay fixed charges on the investment. Take, for example, the New York terminals of the N. Y., N. H. & H. R. R., or the N. Y. C. & H. R. R. R., and suppose that, instead of electrification of their terminals, an improved steam locomotive, which was smokeless and more economical than the main line locomotives, had been used within the limits of the present electrified zone. Under such circumstances, even if the improved locomotives had been better than the outside main line locomotives employed to take the trains to the electrified zone, the cost of providing new locomotives and changing the motive power on all trains entering the zone would have a heavy additional expense sufficient to more than offset a large superiority in the terminal locomotives. The failure of electrification to show a profit under such conditions is not an indication of poor economy of electrical operation, but is due to very unfavorable and costly operating conditions for any kind of motive power. It is well known that some conditions are much more favorable to electric traction, in comparison with steam operation, than others, but none of the practical applications to trunk line operation in America have been such as to realize the conditions that are most favorable for superior economy by electric power. It is fairly established by practice that operation of heavy trains by electric power saves large sums in locomotive repairs and approximately one-half of the fuel as compared with steam locomotive operation. Fuel saving by electric operation is only realized to the best advantage where electric power for railroads is put out from generating stations working at good load factors; and as already explained, this is only realized to the fullest ex-

tent from a diversity of service and large generating stations.

Savings of Electrical Operation.

In the repairs of electric locomotives as compared with steam, there are many who claim that the saving is one-half or more. This saving is generally greater in instances where steam locomotives are replaced by motor car trains than where electric locomotives are used, but the saving in locomotive maintenance and repairs cannot be realized to the best advantage where locomotive runs are short.

There are many secondary savings by electric operation such as increased facility of train movements, additional capacity of terminal yards and crowded main line tracks, reduced cost of track maintenance, ability to operate motor car trains instead of locomotive-hauled trains, etc., but none of these are realized to best advantage in very short runs.

The tendency of modern practice, based on economy of power generation, is working towards the time when all districts in which the aggregate amount of power used in large industries will be served from central power plants located at strategic points reasonably near the centre of distribution, and where conditions are favorable for making cheap power. When competition fairly drives all small power-users (and users of power in less quantity than 5,000 or 10,000 k.w. will eventually be relatively small for certain territories) to seek central power plants for their source of power, then all kinds of power for all classes of work within given territories will be supplied from a single system of high tension transmission lines having branches and spurs such as railroads have in populous countries.

Such conditions already exist in large cities where the lighting and power and street railway companies have centralized their power generating business to a very great extent, but centralization of the power business in more widely distributed areas may become even more complete than in concentrated metropolitan districts.

From such large central stations the supply of power to electric railroad operation will be extended, and will be combined with electric lighting and industrial power business on a large scale, and perhaps with some electrochemical work. This will result in larger plants and better load factors, and consequent reduction in the cost of power, together with monopoly of power business, since the erection of competitive transmission systems would be too costly where the distances to be covered are great.

Transmission Lines.

In order to establish central power plants, supplying power to large areas and to various classes of service, thereby securing large units for power generation and good load factors, it is necessary to have effective means of electric power transmission and distribution. In power transmission, as in power generation, the best economy is secured by handling power in large units. Under ordinary circumstances it would not be profitable to transmit 1,000 k.w. 25 miles, because the first cost and maintenance of transmission lines 25 miles long would entail too heavy a charge for so small an amount of power; but, for large amounts of power, transmission apparatus is economical for very long distances, so that it is often profitable to construct lines over 100 miles long from a source of power supply.

Both the economical size of the plants and their distances apart will largely depend on the total amount of power used in the territory served; and, within certain limits, the greater the amount of power the greater the distance apart of the central stations, since it is economical to transmit large powers longer distances than small powers.

New types of insulators for transmission lines, especially insulators of the suspended type, and a better understanding and application of protective devices for high tension lines against both lightning and short circuits, have made it possible and economical under ordinary conditions to locate generating stations from 100 to 200 miles or more apart, where the quantity of power is large and the other conditions favorable. When once any country or large territory is provided with such transmission lines, with connections to large generating plants, then the electrification of railroads will become quite a different problem from what it is to-day. Steam railroads in such territories contemplating electrification of their lines will not be confronted with the necessity of themselves going into the central station power business, but will be able to purchase power and to accomplish the electrification of their tracks by erecting electric conductors along their right-of-way and purchasing electric motive power apparatus. The purchase of electric power by railroads will become quite as simple as the purchase of coal is to-day; and electric power companies, when once established as described, will be in a position to sell power to all of the various railroads, whether competing or otherwise, which may be located within the territory reached by their transmission lines. Such will be the tendency of progress, because it is the economical thing to do, since it secures the economy of large generating plants working at a good load factor and transmission lines carrying power in large quantities.

Co-operation with Central Stations.

One of the ablest railroad men in the United States takes about this view of the matter: If a railroad requires power for its uses in a country that is supplied from a central station power plant doing a general power business, it is advisable and right for the railroad to purchase its power from such a supply company as long as it does not have to pay the supply company more for such power than it would cost the railroad to produce the power itself; and the railroad in such cases will generally be able to pay a price for its power that will leave the power company a profit, while the railroad will share the prosperity of the power company by the increased transportation business built up through its means. The very fact of the power company having the railroad contracts will assist the company in making the power more cheaply for all purposes, including the railroads, because every additional customer reduces the generating cost per unit of power by increasing the output and load factor of the plant.

At the present time railroad men who are seeking to get electric power plants with good load factors, outside of metropolitan districts, realize that wherever their transmission lines extend they should realize large returns if they are in a position to furnish power for all kinds of work at reasonable rates, and that cheap power develops a country and increases railroad business and affords a secondary source of profit. There seem to be some particularly good opportunities for the sale of power for irrigation pumping from plants designed for railroad power supply in some of the irrigated countries of the Middle Western United States, where, with reasonable priced power, much profitable irrigation work can be done by pumping water where it cannot be supplied by gravity. The same electric power plant that generates electricity for railroad working can be made to automatically start electrically driven pumps whenever the load on the railroad does not utilize the full power of the generating plant. With moderate priced

power, irrigation by pumping promises to become a very large business, and an ideal supplement to a railroad load for equalizing the demand and raising the load factor on power plants. In such work railroads would derive a triple profit from electrification, wherever conditions will justify the substitution of electric for steam locomotives. They will make a saving in the railroad motive power; they will share the advantage of better load factors secured by combining irrigation work on the power plant from which they can take their electric railroad power, and they will get a return on the increased travel and freight business resulting from irrigation works developing the surrounding country. Then, again, the larger the power generating plants become and the more power the railroads use, the more cheaply power can be generated and sold. This will help the territory concerned, not only in irrigation, but in every way that cheap power benefits a district. It follows that everything that goes to increase the size of central stations and improve the reliability and economy of power transmission contributes to improve the means of railroad operation by electric power, and that other classes of power work that build up the size of the plants by improving the load factor can be combined with railroad power to a special advantage. This advantage will be realized by establishing power centres with apparatus and equipment suitable not only for all kinds of railroad work, but also for all kinds of industrial power supply.

Advantages of Large Power Plants.

Every improvement in the economy and efficiency of electric power generation and transmission has furthered the abandonment of small power plants and the adoption of large central station systems. Economy and convenience are so much on the side of large units that a power business, once established under favorable conditions, will naturally grow into absolute control of the business in its territory, especially where the power is supplied over a considerable territory requiring extensive transmission lines. Centralization of power business will result, just as telephone companies have monopolized telephone business in certain districts, because it is more economical and convenient to serve all customers from one system than to keep up two systems.

Generating plants that are favorably located and well established, especially if they have control of water powers or coal mines, have an immense advantage from being first in the field, and every improvement in the means of power transmission and distribution will increase the advantage.

SHOP SECTION
EDITED BY
GEO. W. CRAVENS

Shop Series III.---C. M. & St. P. Railway

The main shops of the Chicago, Milwaukee & St. Paul Railway are at West Milwaukee, Wis., and lie in a valley along the main line of the railroad. They cover an area one-half mile square, and the buildings are very compactly grouped. Provision is made for the manufacture of complete locomotives and for repairs to all kinds of cars, these shops having a maximum capacity of 10 new locomotives per month with repairs to 35 additional and a car capacity of 28 per day.

The car department buildings occupy the west side of the yards in a parallel grouping with a transfer table between the paint shop and the passenger car erecting shop. The locomotive department buildings form an irregular group in the center of the yards. The power station and some minor buildings are to the east. The two roundhouses lie near the main line of the road, which passes to the north.

With the exception of pneumatic hoists and hydraulic presses all machinery is electrically driven, about 95 per cent of the equipment being so operated either in groups or individually. Every well-known maker of motors is represented, and several home made motors are also in use. The entire plant is operated on the 220 volt continuous current system, all current being generated in the company's own power house.

The shops were located here in the eighties and most of the old buildings are of brick. The later ones are of steel reinforced concrete, and all have skylights and large windows. The power transmission was originally mechanical, ropes and belts being used quite extensively. Electrical transmission and drive was adopted in 1903 and has been extended steadily since.

Power Plant and Distribution System.

The main power station at the east side of the grounds is 160 ft. by 100 ft. in size, with a 16 ft. by 50 ft. extension for pumps and feed water heater. The boiler room occupies the entire east side of the building and is 48 ft. wide.

There are eight Babcock & Wilcox 150 h. p. water tube boilers here, arranged in pairs, and four locomotive type boilers of 100 h. p. each. All firing and ash removal is done by hand at present, but mechanical strokers will be installed at an early date.

In the engine room are seven generators and two air compressors and the main switchboard. There are two Bullock 200 kw., 235 volt, 100 r. p. m. generators direct connected to horizontal, cross-compound, 330 h. p. Nordberg engines, and two Milwaukee generators of the same size, also driven by Nordberg engines. Arranged in a row along the center of the room are three upright Westinghouse engines driving 100 kw., 250 volt generators at 290 r. p. m. Two of these are Westinghouse and the other was built by the Milwaukee Electric Co.

The principal auxiliaries in this station include two pumps, a Cochrane feed water heater, a Farbanks-Morse fire pump, 20x12x16 in., operating at 60 r. p. m. and delivering 1,500 gallons of water per minute, and a Laidlaw-Dunn-Gordon air compressor delivering 2,500 cu. ft. of free air per minute for the main shop supply.

There is also an old power house adjoining the large wood mill. This was formerly used to drive that mill by a large belt, but the pulley on engine was replaced by a 350 kw. Bullock 250 volt generator. The engine is a Weisel & Vilter horizontal cross compound and steam is supplied by five return tubular boilers using wood scrap as fuel. The two stations are tied together electrically.

The total connected load is about 5,000 h. p., of which 4,000 h. p. is in motors. The average load is around 3,000 h. p. All leads from generators go to switchboard below floor and all feeders go out overhead. The trans-

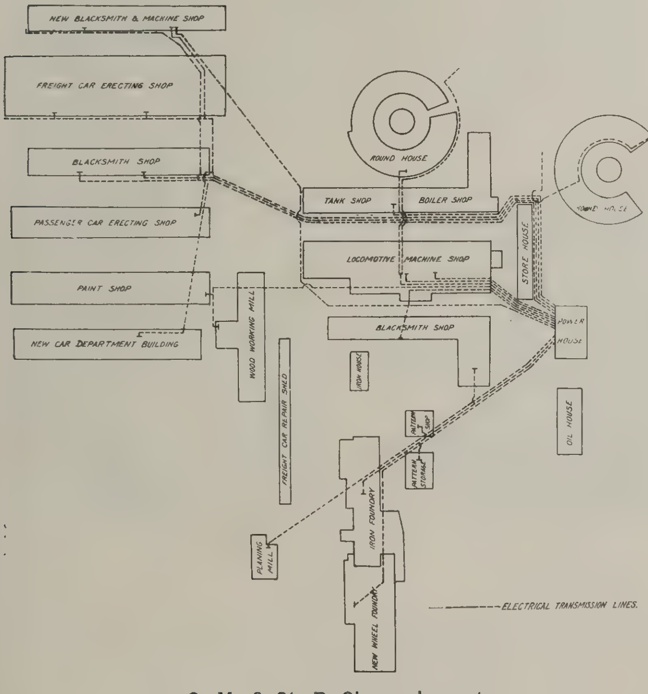
mission and distribution lines are all overhead, weatherproof cables being used. In many places the cables are carried on brackets just under the eaves on outside of buildings, wooden poles being used between buildings and about the yards.

The main switchboard is of white Italian marble mounted on angle bar framework. There are ten panels, each 36 in. wide by 8 ft. high and fitted with two pilot lamps. The switchboard backs up to the wall between engine and boiler rooms. The bus and connection bars

C. M. & St. P. Shops—General View.

are of copper strips laminated to capacity. Removable covers of wood have been placed over the outer bars to prevent contact by operators when back of board. Mounted on the wall back of the switchboard is a single ammeter for reading the current in any feeder circuit. This is done through having a shunt in each feeder connected to contact clips, on a terminal board above the meter, and a plug with flexible leads from the meter.

On the wall near the switchboard is the fire alarm sig-



C. M. & St. P. Shops—Layout.

nal station. This controls circuits for 13 stations throughout the shops.

Locomotive Shop.

The locomotive machine shop is a large building, near the center of the yards, with two extensions added along its south wall. The main building is old and the roof trusses make the use of overhead cranes impossible, so two monorail cranes have been installed to run along one side of the main aisle. In the side bays or new extensions overhead cranes have been installed to handle work for the large machine tools there. A noticeable feature of this shop is the size of the machines installed. Among them is a five-spindle frame drill large enough to take any locomotive side frame made. It was built by Niles-Bement-Pond Co., and has a 5½ h. p. motor on each head, with a separate motor for oil circulation. There is also a three-head frame slotter with a 10 h. p. motor on each head, and 72 in. x 36 ft. planer for the largest frames.

Along the north side of the main aisle are 25 pits for locomotives, all of which are fed from the transfer table immediately north. The general tool room for this shop is located in the center of the building next the aisle. All of the larger machine tools are driven bv individual motors, the balance being driven in groups from motor driven line shafting. The following list gives all of the motor driven tools:

TABLE I.

LOCOMOTIVE MACHINE SHOP TOOLS.

No.	Machine.	H. P.
5	Large drill press, 5-spindle, each	4½
1	Oil pump for above	¼
1	Piston grinder	15
1	Small planer	15
1	Large milling machine	50
1	Large cylinder planer, drive	35
2	Large cylinder planer, traverse	5
1	Large side-frame planer, drive	35
2	Large side-frame planer, traverse	5
3	Small slotters, each	5
3	Medium slotters, each	8
3	Large slotters, each	10
1	Small boring mill	1
1	Medium boring mill	3½
1	Large boring mill	5
1	Portable motor	4
1	100-inch wheel lathe, drive	50
1	100-inch wheel lathe, traverse	5½
1	Large boring mill, drive	30
1	Large boring mill, traverse	4
1	Locomotive guide grinder	15
1	Small metal saw	5
1	Large metal saw	10
2	Large planers, each	20
1	Large wheel lathe	30
1	Large drill press	10
1	Small drill press	4
1	Large slotter	15
1	Hydraulic wheel press, hoist	10
	And the following motors for group drives and miscellaneous uses:	
6	Cranes, total	52
3	Line shafts, each	30
1	Group of drill presses	15
1	Crane, 2 motors, each	5
1	Crane, 2 motors, each	5½
2	Transfer tables, each	10
7	Line shafts, each	30
2	Elevators, each	22

The boiler, tank and tin shops are in the building next north of the locomotive machine shop and are served by the same transfer table. The punches, bending roll and shears are driven by separate motors, all other boiler and tank tools being group driven from a line shaft operated by a 30 h. p. motor. A feature of this building is the large hydraulic riveter for boilers. This sets upright in a tower 60 ft. high, boilers being handled by an electric crane at the top of the tower. The motor driven tools in boiler and tank shops are as follows:

TABLE II.

BOILER, TANK AND TIN SHOPS.

No.	Machine.	H. P.
1	Punch press	5
1	Shear	15
1	Sheet roller	40
1	Punch press	5
2	Punches, each	10
1	Drill press	5

1	Hoist in riveting tower, hoist	25
1	Hoist in riveting tower, traverse	12
1	Hoist in riveting tower, traverse	6
3	Angle iron shears, each	15
1	Large drill press	15
1	Double head shear	15
1	Angle iron shear	20
	Also the following miscellaneous:	
1	Line shaft in Tin Shop	10
1	Elevator in Tin Shop	22
1	Line Shaft in Tank Shop	30
1	Line Shaft in Tank Shop	20
1	Line Shaft in Tank Shop	10
1	Line Shaft in Boiler Shop	30

The locomotive shops are well supplied with cranes, there being five of 2 tons each, two of 10 tons each, and one of 15 tons capacity.

Freight Car Shops.

The freight car erecting shop has a capacity of 28 cars per day. Nine tracks enter this shop and a gantry crane operates along the west end of the building. The new machine and blacksmith shop for freight cars lies just north of the erecting shop, all machine tools except some large ones in the smith shop being driven from line shafts operated by 30 h. p. motors.

Passenger Car and Paint Shops.

Four buildings are devoted to passenger car work and painting, these being the southerly ones of the car department group. The "new car department building," so called, contains the tin, glazing, varnishing, plating and polishing, upholstery, air brake, furniture repair and wood finishing departments. The paint shop occupies a building north of the department building and contains 30 stalls. All coach repairing as well as painting is done here, a feature of ths building being a series of adjustable scaffolds suspended from the main columns of the building. These scaffolds are counterweighted and the load is carried by means of extensions at each end which drop into notches in the columns.

The passenger car erecting shop is the next building north of the paint shop, and transfer table No. 2 lies between them, serving both buildings. There are 30 stalls in this building and all truck work and heavy repairs are done here in addition to erecting new passenger cars. The passenger car blacksmith shop lies next north and all tools therein are line shaft driven. The following table shows the principal motor driven tools in the passenger car shops.

TABLE III.

PASSENGER CAR SHOP TOOLS, ETC.

No.	Machine.	H. P.
1	Pipe cutter	15
1	Sewing machine	2
1	Nickel plating room	1
1	Buffing room line shaft	16
4	Elevators, each	15
1	Line shaft	20
1	Transfer table, outside	40

Blacksmith Shop and Foundry.

The smith work here is distributed among three shops, one for the locomotive department being just south of the locomotive machine shop, and the two for the car department being respectively north and south of the freight car erecting shop. The motor driven tools are as follows:

TABLE IV.

BLACKSMITH SHOP TOOLS, ETC.

No.	Machine.	H. P.
5	Fans, each	30
1	Fan	22
1	Fan	20
2	Bulldozers, each	15
1	Large punch	20
3	Small punches, each	7½
1	Bull dozer	20
1	Bull dozer	30
1	Bradley hammer	30
1	Large punch	23
1	Rolling mill	32
1	Shear	10
1	Shear	15
1	Angle iron shear	27
	Also the following for groups:	
9	Line shafts, each	30
1	Line shaft	20

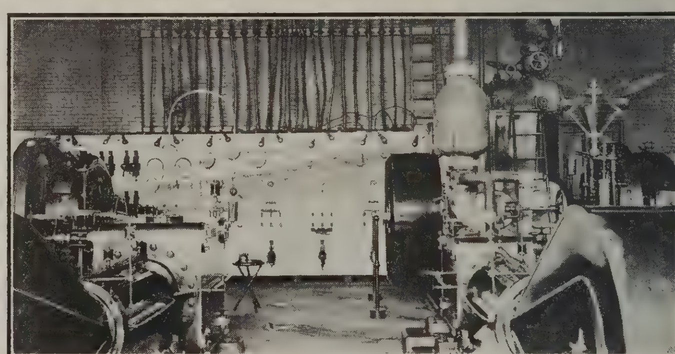
Very complete facilities are provided here for iron casting; the wheel foundry is one of the best in the country. The foundry buildings lie south of the locomotive shops, the grey iron foundry having a capacity of 40 tons of castings of all sizes per day. The capacity of the wheel foundry is 600 chilled wheels per day, there being 24 floors of 25 moulds each and 102 annealing pits. Two cupolas supply the material to load cars on the hot iron track, air hoists on cableways handle the moulds, and motors do all other hoisting and hauling. From the moulds the wheel castings are taken, while still red hot, to cars on the pitting track at the opposite end of the room and from here to the annealing pits where they cool slowly. Barr air chilled moulds are used and unusually good mileages are obtained with these wheels. The motor driven tools are as follows:

TABLE V.

IRON FOUNDRIES.

No.	Machine.	H. P.
1	Cleaning room	10
1	Sand sifters and mixers	7½
1	Sand sifters and mixers	5
1	Blower	50
1	Wheel breaker	15
2	Blowers, each	60
1	Cupola mill	7½
3	Wheel grinders, each	30
4	Truck shifters, each	10
2	Ladle Shifters, each	4
	And the following for groups, etc.	
8	Cranes, each	10
2	Line shafts, each	15
1	Elevator	30

The pattern shops lie to the east of the foundries, and a 30 h. p. Gibbs motor drives all of the tools through a



Power House Switchboard Showing Cables Leading to Overhead Transmission.

line shaft. There are 14 pattern makers' benches in this shop, each completely equipped and well lighted. The elevator is driven by a 10 h. p. Westinghouse motor. The pattern storage building is of steel reinforced concrete, 3 stories in height.

Planing Mill.

There are two wood working mills, a large one between the car and locomotive department shops and a small one west of the foundry. The large mill turns out material for building freight cars and for repairs to both freight and passenger cars. The arrangement of the shop equipment is such that lumber enters the south end in a rough state and leaves at the north end all finished. Practically all machines except planers are group

driven, and two sets of two fans each are installed for shavings removal. Each set is driven by a 75 h. p. motor. Sprinklers are installed throughout, and all wires for lights are in conduits.

TABLE VI.

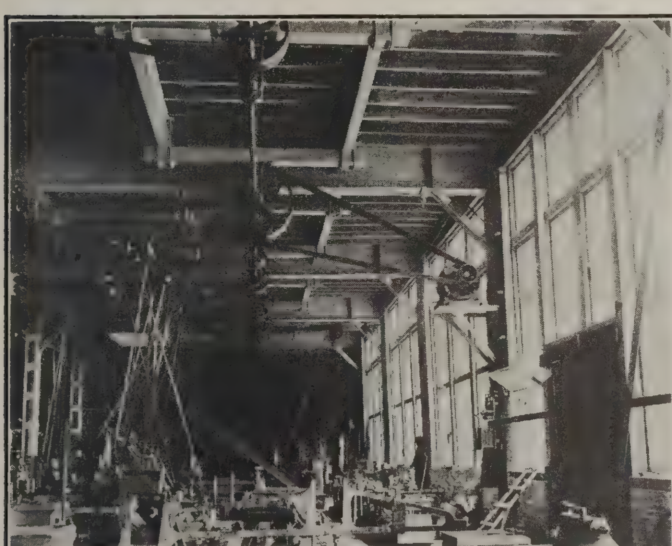
WOODWORKING MILLS.

No.	Machine.	H. P.
2	Planers, each	50
1	Planer	45
2	Blowers, 2 per set, each	75
1	Condenser	30
1	Sanding machine	30
1	Fan	40
1	Group of saws	20
3	Planers, each	30
1	Matcher	20
1	Band saw	15
	And the following for groups, etc.:	
3	Line shafts, each	15
10	Line shafts, each	30
1	Line shaft	45
1	Line shaft	50
2	Elevators, each	25

Roundhouses and Stores.

Both of the round houses here are located at the north end of the grounds near the main line tracks, one containing 43 stalls and the other 30 stalls. Each has an electrically operated turntable with a special swivelling overhead contact block. Hot air heating is provided by steam coils and large motor driven fans.

The coal tower stands at the northeast corner of the grounds and contains four pockets with chutes and scales. The general storehouse is two stories high, heavy material being kept down stairs with light stock above. The motors in the various buildings mentioned are as follows:



C. M. & St. P. Shops—Typical Group Drive.

TABLE VII.

ROUNDHOUSES AND STORES.

No.	Machine.	H. P.
1	Sand Dryer	10
3	Hot air blowers, each	30
4	Turntables, each	10
2	Coal elevators, each	24
1	Store room elevator	10

Shop and Yard Lighting.

The lighting system of these shops is undergoing a change, the present policy being to substitute four-light incandescent clusters for arc lamps. The clusters used are made in the shops and consist of four 60 watt tungsten lamps mounted on an iron cap with a reflector and stem.

Carbon filament lamps of 16 c. p. are used very extensively throughout the shops, several thousand of them being in service, with 48 enclosed arc lamps for yard lighting. Nine Cooper-Hewitt vapor lamps are installed in the locomotive machine shop.

The round houses are lighted with tungsten clusters, as above described, one of them being placed at the end of each alternate space between stalls and near the roof. These are wired to give two lamps in series and 110 volt lamps are used. Exposed rubber-covered wiring is used, the switches being in wooden boxes on the wall.

Miscellaneous.

The yard crane is equipped with a Cutler-Hammer lifting magnet for handling iron and steel of all kinds, and outlet receptacles have been placed at frequent intervals about the yards so the magnet may be connected in at any point. This has been found to be a great time, labor and money saver.

Upstairs over the tank shop is the electrical repair shop where lighting fixtures are made, car and shop lights repaired, armatures re-wound and repaired, and miscellaneous work of similar nature done.

A large open reservoir is built in the vard as an emergency water supply, althou~h city water is brought into the grounds. Wide roadways pass around all of the principal buildings and fire hydrants and alarm boxes are scattered about the grounds.

DISTRIBUTION OF POWER

Department	Lighting			Motors							
	Incandescent	Arc	Mercury Vapor	Machine		Crane		Transfer		Elevator	
				No.	HP.	No.	HP	No.	HP.	No.	HP.
Locomotive Machine Shop	300	[illegible]	9	53	725	10	73	2	20	2	44
Boiler & Tank Shop	600	---	---	21	288	--	--	--	---	1	22
Passenger Car Shop	200	---	---	5	54	--	--	1	40	4	60
Paint Shop	225	---	---	--	---	--	--	--	---	--	--
Blacksmith Shop	100	15	---	31	741	--	--	--	---	--	--
Foundry	150	---	---	19	382	8	80	--	---	1	30
Wood Working Mills	500	20	---	29	1130	--	--	--	---	2	50
Round Houses and Stores	200	10	---	4	100	--	--	4	40	1	10
Yards	200	50	---	--	---	--	--	--	---	2	45
Power Station	50	10	---	--	---	--	--	--	---	--	--
TOTAL	2425	135	9	162	3420	18	153	7	100	13	254

Table Showing Power Distribution.

Large wheel and axle storage spaces are provided, the principal one being east of the freight car shops, and a large lumber storage yard is located just south of the car department buildings.

The thanks of the writer are hereby extended to Mr. C. R. Gilman, Chief Electrician of the C. M. & St. P. R. R. for his valuable assistance in supplying much of the above data.

TELEPHONE TRAIN DISPATCHING RULES

The United States Electric Company has issued in its Bulletin No. 502 some suggested rules for telephone train dispatching. These rules are a compilation of the requirements generally adopted by the majority of American railways which have installed telephone train dispatching. As reflecting the consensus of judgment of users, these rules are of interest to roads contemplating the change to telephone dispatching. Some general instructions governing the use of the telephone in railway service follow and it is believed that, as simple as some of these appear, they have an important bearing on the efficiency operation of a railway telephone installation.

"The Delta Star Electric Company, Chicago, Ill., manufacturers of high tension specialties, have removed to 617-631 W. Jackson Blvd., where increased manufacturing and office facilities have been secured. In addition to high tension devices a complete line of high efficiency Mazda lighting units have been developed and will be placed on the market July first."

Mr. G. H. Stickney, of the General Electric Company, has been transferred from Schenectady to Harrison, New Jersey. He will hereafter devote his whole attention to the Incandescent Lamp Sales Department.

Railway Telegraph Superintendents Convention in Boston

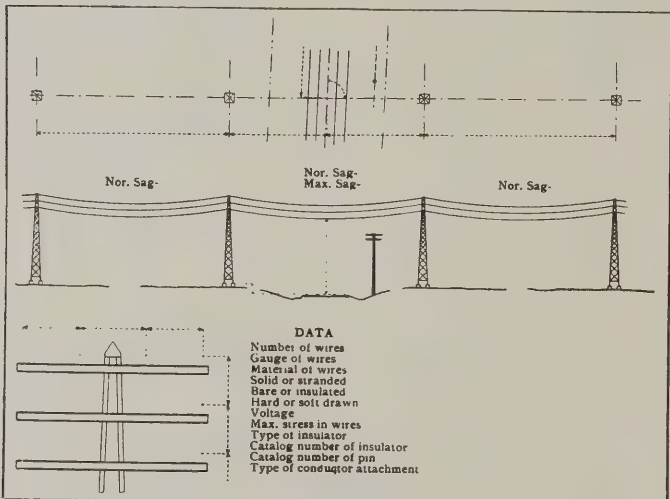
The annual convention of the Association of Railway Telegraph Superintendents, held in Boston, June 26-30, was the thirtieth in the history of the organization. The total attendance of members and guests was 125. In the absence of President Dyer, who was unable to be present on account of illness, Vice President J. B. Sheldon presided.

The total membership of the association, as shown by the report of Secretary Drew was 169, at the opening of the meeting. In addition to these, 35 new members were elected. The association is in a flourishing condition, a balance of $302 above all expenses being shown by the treasurer's report.

Hints.

By W. J. Camp.

In his paper, "Hints," Mr. W. J. Camp, electrical engineer of the Canadian Pacific at Montreal, made a comparison between porcelain and glass insulators, saying that the former were harder and not so easily shattered by impact of stones and that their insulating qualities were from 5 to 10 times as good as those of glass insulators. White porcelain insulators are now purchased exclusively on the Canadian Pacific.



Overhead Crossing Committee's Drawing for Typical Crossing of Steel Pole Line.

Telephone dispatching circuits are transposed every quarter mile. The transposition is effected by means of a curved iron bracket under the arm, which decreases the danger of crosses in case of broken insulators. Main line bridging selectors are used. Argus lightning arresters are used, four, without fuses on the ends of the wires and two, with fuses, on the bridge wires to the telephones and selector.

Each telephone inspector covers a stretch of 250 to 300 miles. Mr. Camp believes that each inspector should be provided with a light motor car. Each train is equipped with a telephone, connection to the line being made with a pole.

In the discussion of Mr. Camp's paper, it was brought out that the cost of porcelain insulators is 4.2 cents, while that of glass insulators is 2.9 cents. Breakage of porcelain insulators averages less than one per cent.

Railway Efficiency.

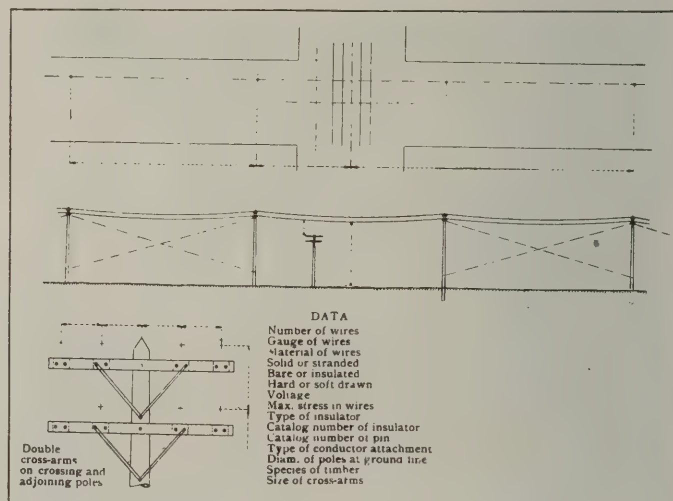
By Ralph W. Pope.

Mr. Pope's paper called attention to the advance of "scientific management," which he said had its application to the telegraph department as well as to other branches of railway work. Mr. Julius Kruttschnitt has said that "A railway is a machine designed to manufacture freight and passenger service; it makes ton-miles and passenger-miles." Its efficiency increases in direct proportion to the rapidity with which trains are handled and this rapidity is largely dependent on the dispatching service. Mr. Pope thought the telephone could advantageously be employed in many departments of railroad work.

Telephone Economy in Railway Service.

By G. K. Heyer.

This paper reviewed the steps in the introduction of the telephone for railway service and pointed out the difficulties that had arisen and been overcome. The possibilities of improvement were mentioned and attention was called to the extremely rapid expansion which has taken place, there being today nearly 48,000 miles of railway telephone circuits in the United States and Canada. The various points of advantage of the telephone over the telegraph were listed. An



Overhead Crossing Committee's Drawing for Typical Crossing of Wooden Pole Lines.

argument was made for a system of records or accounts by which the actual cost of operation of the two systems could be compared.

High Tension Crossing Committee Report.

This is a joint report which has been approved by the National Electric Light Association, American Electric Railway Association, American Telephone Company, Postal Telegraph Co. and Western Union Telegraph Co. Typical crossings as recommended by the report are shown in the illustrations.

Election of Officers.

The Officers elected for the coming year are: President, G. A. Cellar, Pittsburgh; 1st vict-president, W. M. Bennett, Chicago; 2nd vice-president, A. H. Taylor, New York; secretary-treasurer, P. W. Drew, Chicago. The next annual convention will be held in New York City, June 24, 1912. The committee on arrangements is W. W. Ryder, Chicago; U. J. Fry, Milwaukee; W. Marshall, Toronto.

General News and Personal Mention

A NEW SHOP LIGHTING FIXTURE.

Among the problems of engineers charged with the electric lighting of railroad equipment is that of efficient shop lighting, both from an electrical and commercial standpoint. It is not only important that the highest possible illuminations be secured from a given energy expenditure, but also that a type of lighting unit be adopted which will have as low an installation and maintenance cost as is possible to secure.

The advent of the Mazda lamp in combination with properly designed fixtures offers a most practical solution of the problem, as this combination possesses the two desirable features of high efficiency and low maintenance cost. To meet the demand of shop lighting, the lighting unit illustrated herewith has been developed by the Delta-Star Electric Co., of Chicago, and is known as the "Mazdalite."

A unique feature of the Mazdalite is that it is water, smoke and gas proof, this being secured by the use of a one-piece reflector in turn having a substantial glass globe properly gasketed at the point where it engages with the reflector. To secure an efficient and permanent reflecting surface the fixture is finished in fire enamel porcelain, the top side being finished in

"Mazdalight" Four-Lamp Fixtures.

dark blue, thus securing a surface which will not deteriorate under the most trying conditions of water, smoke or gas.

The enclosing globe is removable, permitting easy replacement of lamps and at the same time serves to collect dust which would ordinarily collect on the lamps of an unshielded fixture. The result is that all dust can be effectually removed from the globe without in any way handling the lamps and causing breakage.

Four 250-watt Mazda lamps are used in either series or multiple as desired, this of course depending upon the voltage of the circuit and the result is a lighting unit which effectually replaces the ordinary type of flame arcs and at the same time has an extremely low maintenance cost. Where vibration is exceedingly heavy the fixtures are provided with shock absorbers, although as a rule the modern Mazda lamp does not require this precaution, unless the vibration is unusually severe.

DEATH OF WILLIAM RICHARD BRIXEY.

It is with regret that we chronicle the death of William Richard Brixey, one of the leaders in the development of insulated wires and cables.

W. R. Brixey.

Mr. Brixey was born at Southampton, England, May 11, 1851, educated at a well-known grammar school there and then entered the British Mercantile Marine service, commanding his own ship and visiting all the leading ports of the world. He came to this country in 1878, became at once an American citizen, and went into business with his brother-in-law, Mr. A. G. Day, a pioneer in the American rubber industry and the inventor of "Kerite." In 1879 he married Miss Frances N DeWolfe, daughter of Alva G DeWolfe, a co-worker of Mr. Day's and also an inventor of some note. The Day plant was at Seymour, Conn., and there Mr. Brixey developed the business with remarkable energy and intelligence, mastering it in every detail and becoming general manager on the death of Mr. Day, and sole proprietor upon the death of his sister, Mrs. Day. Mr. Brixey was not satisfied with the use of his cables in the telegraph and telephone field or with the early indorsement of such men as Morse, but pushed out into larger developments in other fields. Noteworthy among these developments were the supplying and laying of the Alaskan cable, the furnishing of the Panama Zone cable, and furnishing the wires and cables for the Pennsylvania tunnel and terminal connecting the two shores of the Hudson and East Rivers. In 1908 Mr. Brixey incorporated the business as a company and soon after retired, leaving it to the management of his eldest son, Mr. Richard D. Brixey, president of the Kerite Insulated Wire & Cable Company. Mr. Brixey left two other sons, Mr. Reginald W. Brixey, vice-president, and Mr. Austin D. Brixey, secretary of the company. Mr. Brixey was quite active in public life, and was a captain of the Old Guard of New York City. He was a member of the A. I. E. E. and a thirty-third degree Mason. Mr. Brixey's wife died in 1909 and he is survived only by the three sons above mentioned.

The Safety Car Heating & Lighting Company announces that Mr. H. C. Wheeler, formerly of the New York office, has been transferred to Montreal, Canada, where he will look after the Canadian interests of the company.

The completion of the new building for which ground was broken last week will add 8000 square feet of floor space to the Willard Storage Battery Company's plant at Cleveland, Ohio. The building will front on Marquette Road and is built to take care of the Company's rapidly increasing business.

The Dope Sheet

WOODWORKING MACHINERY. Power to Drive.

Name of Tool	Nature or Material	R. P. M. Driving Shaft	R. P. M. Tool	Cut	Cu.In. Per Sec.	HORSE -- POWER No load	Max.	Ave.	Ave. Useful
Mortiser	Oak	350	380	1¼"Bit		0.8		1.2	0.4
Nut Mortiser	Med. Oak		1025	1"x 1" x3"		4.3		4.8	0.5
Mortiser	Green Oak	265	310	1½" x 2¼"		3.1		7.1	4.0
Hollow Chisel Mortiser		1000				5.8		11.4	5.6
Large Chisel Mortiser	Green Oak	1210	1050	1½" x 2"		5.8		11.4	5.6
Tenoner	Green Oak	725	710	1½" x 8"		7.0		8.5	1.5
Tenoner	Green Oak	885	795	6" x 8"		5.2		26.8	21.6
Tenoner	Dry Oak	900	930	1½"x8"x4"		5.7		9.2	3.5
Tenoner	Dry Oak	830	830			1.83		3.2	1.4
Tenoner	Dry Oak	1110	1160	1¾" x 5/8"		1.83		3.2	1.4
Shaper		1000	1040	1/8"x3-7/8"		5.5		6.7	1.2
Shaper		1000	1000			5.5		6.7	1.2
Shaper		750	750			5.5		6.7	1.2
Matcher	Geo. Pine	840	800	3¼" x 12½"to 7¾" x 11¾"		1.4		3.1	1.7
Gainer 16"Head		600	1700		9.3	3.0	10.5	8.5	5.5
Rotary Mortiser	Oak	600		1½"x4"x2"	1.38	2.8	4.8	4.2	1.4
	Oak	600		½"x5¾"x17½"	2.19	2.8	5.5	5.0	2.2
	Oak	600		Countersink	1.64	2.8	6.0	5.5	2.7
Large Tenoner				3¾"x5"x10"	7.8	4.0	11.0	8.5	4.5
				3¾"x3½"x10"	12.5	4.0	9.0	8.5	4.5
				4¼"x7½"x10"	15.9	4.0	13.5	11.5	7.5
				3¾"x7½"x10"	18.7	4.0	13.5	12.0	8.0
				3¾"x7½"x10"	23.4	4.0	15.2	13.0	9.0

*From Actual Tests in a large Railway Shop.

WOODWORKING MACHINERY. Power to Drive—Planers.

Name of Tool	Material	R.P.M. Tool	Ft.P.M. Tool	CUT Width	CUT Depth	HORSE - POWER No Load	Start	Max.	Ave.	Useful
S.A.Wood 16" Buzz belted to 5 HP. motor	Ash	4000	5230	11½"	3/16"	1.5	6.3		10.	8.5
	Ash	4000	5230	11½"	¼"	1.5	6.3		10.7	9.2
24 Inch Buzz geared to 5 HP Motor	Ash	4000	6282	13"	1/8"				3.6	
	Ash	4000	6283	13"	3/16"				3.8	
	Ash	4000	6282	13"	1/4"				4.2	
	Ash	4000	6282	13"	5/16"				4.6	
	Maple	4000	6282	2"	1/8"				2.1	
	Pine	4000	6282	2½"	1/8"				2.0	
15 Inch cylinder belted to 7½ HP Motor	Hickory	3675	4820	5"	3/16"	3.0	8.1		6.3	3.3
	Pine	3675	4820	6"	5/16"	3.0	8.1		5.0	2.0
	Pine	3675	4820	6"	1/4"	3.0	8.1		3.6	0.6
24 Inch cylinder geared to 7½ HP Motor	Spruce	3725	4800	8"	3/16"	3.0	10.7		4.1	1.1
	Spruce	3725	4800	18"	3/16"	3.0	10.7		8.2	5.2
	Spruce	3725	4800	24"	3/16"	3.0	10.7		12.3	9.3
	Spruce	3725	4800	12"	1/8"	3.0	10.7		18.0	15.0
	Pine	3725	4800	14"	1/8"	3.0	10.7		6.7	3.7
	Pine	3725	4800	8"	1/4"	3.0	10.7		7.3	4.3
	Pine	3725	4800	8"	3/8"	3.0	10.7		8.7	5.7
	Ash	3725	4800	6"	1/2"	3.0	10.7		9.3	6.3
	Ash	3725	4800	20"	5/32"	3.0	10.7		15.4	12.4
	Ash	3725	4800	20"	1/8"	3.0	10.7		12.8	9.8

* From actual tests in a large railway shop.

WOODWORKING MACHINERY. Power to Drive.

Name of Tool	Nature or Material	R. P. M. Driving Shaft	R. P. M. Tool	Cut	Cu.In. Per Sec.	HORSE POWER No Load	Max.	Ave	Ave. Useful
Sash Mortising Machine		340		5/8"x2⅝"x10"	0.38	0.5	5.5	4.0	3.5
Two Spindle Boring and Mortising Machine	Mortising	288		1½"x4"x 2"	1.33	1.5	5.0	4.5	3.0
	Boring Oak	288		1¾" x 9" Hole	2.41	1.5	3.0	2.1	0.6
5-Spindle Boring Mach.	Oak			2" x 6" Hole	4.2	6.0	8.5	7.75	1.75
Univ.Wood Worker,Small.	Oak	548		Boring 1" Hole		0.5	2.0	1.25	1.75
Univ.Wood Worker,Large.	Yellow Pine	960		3"x 1¼"x 6"	14.5	1.5	12.5	9.6	8.1
	Yellow Pine	950		2"x4"x9'3" to 1¾"x 5½"	12.6	5.45	10.6	10.35	4.9
Boring Machines:									
One spindle		1200				1.1		5.6	4.5
One spindle		800				1.83		7.0	5.17
One spindle		600				.48		1.0	0.52
One spindle		280				.67		1.65	0.98
Two spindle	Green Oak	360	400	1¾" x 8"		6.9		8.8	1.9
Three spindle		360				6.8		8.4	1.6
Four spindle	Georgia Pine	320		2¼" x 4½"		7.75		10.5	2.75
Five spindle		310				10.3		14.5	4.2

*From actual tests in a large railway shop.

WOODWORKING MACHINERY. Power to Drive—Planers.

Name of Tool	Material	R.P.M. Shaft	CUT Width	CUT Depth	Cu.In. Per Sec.	HORSE - POWER No Load	Max.	Ave.	Ave. Useful
J.A.Fay & Co. 10Ft. x 28 Ft.	Rough Oak	945	14½"	1/8"	12.8	8.0	19.85	15.65	7.65
	Oak	945	14½"	3/16"	19.2	8.0	24.55	20.15	12.15
Endless Bed	Yellow Pine	930	6½"	½"	26.0	7.6	19.4	18.2	10.6
	Yellow Pine	930	8"	½"	35.7	7.6	21.1	18.7	11.1
	Yellow Pine	930	12"	⅛"	24.0	7.6	30.6	26.0	18.4
24 Inch Surface	Rough Y.P.		12½"	1½"	14.0	2.5	9.5	8.5	6.0
	Yellow Pine		12¼"	1-1/8"	18.6	2.5	12.1	11.5	9.0
	Poplar		19"	3/4"	34.0	2.5	12.1	12.0	9.5
--------------	Rough Y.P	830			25.6	10.0	29.0	24.5	14.5
	Rough Oak	830			33.0	10.0	37.5	26.0	16.0
	Oak	830			42.4	10.0	43.0	41.5	31.5
	Oak	830			48.6	10.0	63.0	50.5	40.5
	Rough Oak	830			19.2	10.0	46.5	26.5	16.5
Daniels			11¼"	3/16"	8.44	3.7	10.0	8.75	5.05
Daniels 25" Head	Ash		12⅛"	1/8"	6.15	1.0	11.0	6.5	5.5
Planing and Siding Machine	Yellow Pine	900			30.8	8.0	31.0	29.5	21.5
	Oak	900			23.5	8.0	33.0	32.0	24.0

* From actual tests in a large railway shop.

RAILWAY ELECTRICAL ENGINEER

WITH WHICH IS INCORPORATED THE

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

Progress in Car Ventilation.

SOMETHING has been done to improve car ventilation during the past year. Practically all sleepers are now equipped with ventilators of the stationary type. There can be no doubt that these have done a great deal to better the air in cars. This type of ventilator depends for its action upon the motion of the train and shows to greatest advantage on through trains which run at fairly high speeds. It leaves something to be desired, of course, but nevertheless it is vastly better than no ventilator at all and the absence of moving parts is a decided advantage.

With all the discussion which has taken place on the subject, the question as to whether car ventilation should be by exhaust or positive pressure remains unsettled. There is general agreement that if pure clean air could be forced into the car under uniform pressure ideal ventilation would be accomplished. It seems to be very difficult to devise a method for doing this. Not the least of the difficulties is that of securing the clean air. The envelope of air surrounding a railway train in motion is always more or less contaminated by cinders, smoke and dust. To remove these requires filtration of some sort. The air must be either washed or screened. Washing is likely to be accompanied by too great absorption of water vapor with the result that the car is made damp and the supply of wash water must be frequently changed and renewed. Screening is difficult because if screens of sufficient fineness to accomplish the desired result are used, they fill up rapidly and soon become impervious.

Some authorities maintain that the air could be rid of the greater share of its dirt by being drawn through a duct having a downward bend. This would necessitate the use of a positive pressure blower of some power as the air friction in long ducts is considerable. There is no serious obstacle in the way of using this system of ventilation unless it be that of finding space for the ducts. In a sleeping car air would have to be furnished to each berth which would require a rather elaborate system of air passages.

So far the exhaust or vacuum system has been used in all efforts of car ventilation, except that which makes use of revolving fans to draw air into the car through the deck sash. Granting that the positive pressure system is superior, this is a step in the right direction. However, the efficiency of fans revolving in free air is very low. To get the full benefit of the power used in them they must be enclosed in ducts. Some experiments along this line are being made at present.

Unfortunately very little reliable data on the efficiency of car ventilating systems is available. The tests made by the Chicago Railways Company, the results of which were published in the RAILWAY ELECTRICAL ENGINEER for August, 1910, are about the only actual comparative observations ever made.

While all sleepers are now equipped with some form of ventilator, not over 5 per cent of the coaches and chair cars in service have as yet received attention. Nevertheless the progress made is encouraging since it is only within the last few years that the question of car ventilation has received any attention.

The Committee on Ventilation of the Association of Railway Electrical Engineers is doing pioneer work in a long neglected field. It would seem that there are several fundamental questions which this committee report should settle or at least try to settle. These are:

1. Which is best adapted for car ventilation—a positive pressure system or a vacuum system?
2. How much fresh air should be furnished per passenger per hour (or other unit of time)?
3. Is it necessary to clean this air?

The report of this committee will be awaited with much interest as it will be the first authoritative report on the subject.

ASSOCIATION NEWS.

This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.

It will be open to communications pertinent to association matters. Any member who has anything to say to the other members is invited to make use of this column for that purpose. Such communications should be addressed to the secretary of the association.

NEW MEMBERS.

The following new members were approved at the Executive Committee meeting held on July 12, 1911:

Anton Abrams, 409 Garfield Bvd., Chicago, Ill.

Joseph Appleton, 608 Jefferson Ave., Niagara Falls, N. Y.

Frank L. Baxter, General Elec. Co., Harrison, N. J.

Laurence P. Ball, H. W. Johns-Manville Co., Chicago, Ill.

Frank Black, 315 Newman St., Bay City, Mich.

M. B. Buckman, 124 So. 8th St., Philadelphia, Pa.

Gustave Carlson, 522 W. 58th St., Chicago, Ill.

F. R. Fortune, 1501 Arnot Bldg., Pittsburg, Pa.

Chas. H. Gazetty, 629 Market St., Philadelphia, Pa.

Geo. A. Graber, 1955 Peoples Gas Building, Chicago, Ill.

Geo. Hentges, 2335 State St., Chicago, Ill.

Chas. W. Hunt, 317 Hill St., Rocky Mountain, N. C.

Fred E. Kuhl, 2627 Eagle Ave., Alameda, Cal.

Alex. B. Moore, 114 Oak St., Ludlow, Ky.

Arthur W. Martin, 14 Manness Ave., Portland, Me.

J. Lee Parker, 46 Mary St., Maycross, Ga.

Robert E. Price, 406 8th St., Oakland, Cal.

H. Worcester Sargent, 203 5th St., New York City.

John J. Schayer, 1153 Peoples Gas Bldg., Chicago, Ill.

Robert Skeen, 400 Glisan Ave., Portland, Ore.

Harry W. Smith, 105 19th St., Buffalo, N. Y.

Theo. D. Starr, 323 Moreland Ave., Philadelphia, Pa.

Nelson G. Stark, Oneida Steel Pulley Co., Oneida, N. Y.

C. G. Tarkington, 1420 N. Y. Life Bldg., Chicago, Ill.

B. F. Wood, 1200 2nd St., Juniata Station, Altoona, Pa.

CHICAGO ELECTRIFICATION COMMISSION STAFF.

The staff of H. G. Burt, chief engineer of the commission appointed by the Chicago Association of Commerce to report on the feasibility of electrifying the railway terminals of Chicago is announced as follows:

Electrical Engineer, Hugh Pattison. Mr. Pattison has been connected with the electrical equipment of the Pennsylvania railroad tunnel and terminal in New York city.

Mechanical Engineer, Theodore H. Curtis. Mr. Curtis has been for several years past, superintendent of motive power and machinery of the Louisville and Nashville Railroad.

Terminal Engineer, Louis H. Evans. Mr. Evans has been chief engineer of the Chicago Junction Railway and was in charge of the first track elevation by the Chicago & Northwestern Railway in the city of Chicago.

The studies of the commission will be carried on under these three heads.

VENTILATION AND COOLING.

The question of the comfort of passengers in railway cars is not altogether one of adequate ventilation. It is partially dependent on the circulation of the air in the car. The two uncomfortable sensations, heat and "stuffiness," are associated in the mind because they are usually experienced at the same time. They are, however, experienced for different reasons, and what will remedy one will not necessarily remedy the other.

Air removes impurities from the body through the lungs and skin. In the lungs, impurities are oxidized and removed as gases, chiefly carbon dioxide. Continuous action of this sort is necessary to life. Anything which impedes this action causes a feeling of discomfort. The capacity of air to oxidize the impurities in the lungs varies with the amount of free oxygen it contains. A considerable amount of this oxygen is used up when the air is breathed. Hence air breathed the second time is not so effective as fresh air in removing impurities. After being inhaled several times it becomes saturated with the gases given off by the lungs and is of little value for breathing. For this reason it is necessary that the air in an enclosed space should be changed frequently. This changing of the air constitutes ventilation.

Impurities leaving the body through the skin do so in a solution called perspiration. This perspiration escapes to the outer surface of the skin through the pores. The physiological purpose of perspiration is two-fold. In addition to carrying off impurities it has a cooling effect. This cooling is due to evaporation on the surface of the skin. In evaporating, the water in perspiration becomes water vapor. This change from a liquid to a gas is accompanied by the absorption of heat. This heat is taken from the skin and the temperature of the body is therefore lowered.

The amount of heat removed is in direct proportion to the rapidity of evaporation. The rapidity of evaporation depends upon the amount of air coming in contact with the skin and the temperature of that air. As the temperature varies only within narrow limits, the amount is the controlling factor. The amount depends upon the motion of the air. In perfectly still air evaporation is comparatively slow and the cooling effect of perspiration is therefore slight. To insure entire comfort it is necessary that the air should be in motion. Of course all air in a moving car is more or less in motion but any motion so slight as to be imperceptible has very little cooling effect.

The air in a car may be changed as frequently as is required for the lungs without perceptible motion. Hence a perfectly ventilated car may not be perfectly comfortable. Some means of securing motion of the air must be provided. This motion need not be so rapid as to form what is ordinarily called a "draught," but it must be perceptible.

To create this motion of the air is the function of a fan. Unless the motion induced has a definite direction such that it results in the air in the car being changed the fan has no ventilating effect whatever. The fact that it does not ventilate is, however, no objection to the fan. Stirring us the air may not be as important from the physiological point of view as changing it but it is quite as important to the comfort of the passenger.

Summing up, the comfort of the passenger demands both fresh air and air in motion, or in other words, both ventilation and cooling. Stirring up the air does

not lower its temperature nor purify it but it does lower the temperature of the body by evaporation of perspiration from the skin. Therefore, fans are necessary for comfort whether they have anything to do with the ventilating system or not.

VENTILATION CALCULATIONS.

The problem of ventilating any enclosed space such as the interior of a railway car consists simply of providing means whereby the foul air will be removed and replaced with fresh air often enough to give each person 1,000 cubic feet of fresh air per hour. In so doing use is made of openings of various sizes. Frequently these openings lead directly to the outer air; sometimes the outer air is reached through ducts. The problem then is to provide openings of sufficient size so that with the air speeds obtainable, the requisite change may be effected.

In the solution of this problem, the accompanying table may be of value. Taking a specific case, let us suppose that a car carries 50 passengers and therefore requires theoretically 50,000 cubic feet of air per hour. If, by fans or other means a velocity through the openings of 20 feet per minute (equivalent of a 15 miles an hour breeze) can be secured, 20 openings of 300 square inches cross sectional area or 40 half as large will be required.

Flow of Air in Cubic Feet per Hour through Various Sizes of Ducts at Different Speeds.

Area of Duct X-Section. (Sq. In.)	Speed of Air in Feet per Minute										
	1	2	4	6	8	10	12	15	20	25	30
12	5	10	20	30	40	50	60	75	100	125	150
24	10	20	40	60	80	100	120	150	200	250	300
36	15	30	60	90	120	150	180	225	300	375	450
48	20	40	80	120	150	200	240	300	400	500	600
60	25	50	100	150	200	250	300	375	500	625	750
72	30	60	120	180	240	300	360	450	600	750	900
84	35	70	140	210	280	350	420	525	700	875	1050
96	40	80	160	240	320	400	480	600	800	1000	1200
108	45	90	180	270	360	450	540	675	900	1125	1350
120	50	100	200	300	400	500	600	750	1000	1250	1500
132	55	110	220	330	440	550	660	825	1100	1375	1650
144	60	120	240	360	480	600	720	900	1200	1500	1800
160	67	133	267	400	533	666	800	1000	1333	1667	2000
180	75	150	300	450	600	750	900	1125	1500	1875	2250
200	83	167	333	500	667	833	1000	1250	1667	2083	2500
240	100	200	400	600	800	1000	1200	1500	2000	2500	3000
300	125	250	500	750	1000	1250	1500	1875	2500	3125	3750

Mechanical Car Ventilation

Mechanical Car Ventilation is a term applicable to those systems of car ventilation which do not depend for their operation upon the circulation of air induced by the movement of the car or external wind pressures.

A mechanical system of car ventilation provides for a constant circulation or flow of air through the car under all operating conditions.

Natural Car Ventilation covers those systems which depend for operation upon some modified form of the aspirator principle, or upon some combination of the various types of injectors operating by reason of the wind pressure induced by the speed or movement of the car.

Mechanical car ventilation may operate upon either the exhaust or vacuum system or upon the positive pressure system. In the first, fresh air is forced into the car. In the second the foul air is drawn out by suction and replaced by fresh air which flows in to fill the resulting vacuum. No mechanical positive pressure system has as yet been extensively used, but the vacuum system has been installed and in service for some time.

In this system a motor-driven exhaust fan is utilized, usually located at the car roof at one end, having a connection with an exhaust chamber located between the roof plates and head lining, and extending the length of the car roof. In the lower face of this exhaust chamber is located a series of outlet registers opening into the car interior and offering an outlet for the air handled by the exhaust fan. Provision is made for the fresh air supply by means of a series of fresh air intakes located at or near the floor line of the car and connected with the car heaters or radiating surface so as to insure heating the fresh air which replaces the air withdrawn by the exhaust fan.

The application of the electric motor in connection with car ventilation on steam railroads has been made possible by the increasing use of electric current for Car Lighting. Passenger equipment is now generally provided with electric car lighting by means of turbo-generator sets or axle-lighting systems in combination with storage batteries.

The vacuum system of car ventilation was first designed and applied to surface cars for city service in Chicago. The necessity of a positive means of car

ventilation has become apparent with the advent of the enclosed type of motor cars, which are now generally used in city and interurban service.

Some three years ago a series of exhaustive tests were instituted and conducted by the railway officials and the Board of Health in the city of Chicago. Cars were equipped with the various ventilating devices on the market and placed in actual service. As a result of these tests a contract was given to equip 350 cars with the mechanical system offered by the Vacuum Car Ventilating Company. These cars have been in service during the past year, and various tests have been made to determine the scope of the ventilating system. An air analysis test to determine the quality of air in cars and percentage of CO_2 was made by the Illinois Chemical Laboratory, the results of which were reported as follows:

"We boarded Chicago Railway Car No. 916 (Pullman type, pay-as-you-enter) at Halsted street and Fullerton avenue at 2:30 p. m. Wednesday, January 11, 1911. The car at that time contained 36 passengers in the body of the car. The air did not seem to be contaminated. The electric fan was turned off for 30 minutes. At the expiration of that time the car contained 35 passengers. We filled a bottle with the air of the car by passing some through the bottle by means of a suction pump for eight minutes. The car at this time had arrived at 22d and Halsted streets.

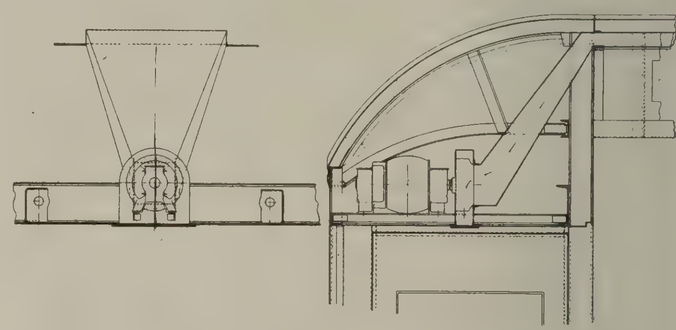
On determining the amount of carbon-dioxid in the above mentioned bottle we found it to be 12.9 parts per 10,000. The fan was then turned on again. In 30 minutes another sample of air was taken in a similar manner (the car containing 65 passengers). This sample showed 10.3 parts of carbon-dioxid per 10,000. This was a very good showing, considering the line the test was made on (as Halsted street is one of the worst lines in the city, owing to the class of people that use that line).

"On Saturday, January 14, 1911, another test was made on Chicago Railways Car No. 930, running in service on Halsted street and Milwaukee avenue. The car contained 62 passengers. We filled bottle of air by pumping nine minutes with suction. The fan was running when we entered the car. On determining the amount of carbon-dioxid in bottle, it was found to be 5.4 parts per 10,000. In five minutes after we filled bottle with air, we were at end of the line, Halsted and 26th streets. The fan was turned off fifteen minutes later. The return trip was started at Madison and Halsted with 14 passengers in car, bottle of air was taken by pumping for nine minutes, car contained 8 passengers at conclusion of pumping. On determining amount of carbon-dioxid it was found to be 6 parts per 10,000."

Inasmuch as the question of car ventilation must be considered in connection with the car heating, it was obvious that proper provision must be made for heating the fresh air supply, in order to prevent chilling the car in cold weather. It was believed that it would be impossible to heat a car when a 3½-minute air change was provided without greatly increasing the radiating surface necessary to maintain the desired temperature.

Under date of Jan. 4, 1911, a test was conducted on the car heating system on one of the cars equipped and in service on the lines of the Chicago Railways Co. The results of the test showed that it is possible to maintain the desired temperature without increasing the current consumption, or, on steam roads, the steam consumption, in the heating system. In order to insure accuracy in the observations taken, car temperatures were recorded by means of clinical thermometers placed through the car at various levels. A number of capacity tests have been made, which show clearly that the standard outfit is capable of producing a 3½-minute air charge under all operating conditions, in a standard 31'-0" car body, and the circulation of air established by the exhaust fan is not affected by the car movement or external atmospheric conditions.

It is believed that the application of this system may readily be made to steam cars with highly satisfactory results. The cuts given below illustrate the tentative layout to cover such application. Provision could readily be made for an exhaust chamber space duct between the car head lining and roof plates. A series of outlet registers could be installed in the lower face of this duct and the exhaust chamber connected



Showing Location of Fan Over Vestibule.

to the exhaust fan and motor, located preferably in the bow of the roof of the car over the vestibule at one end.

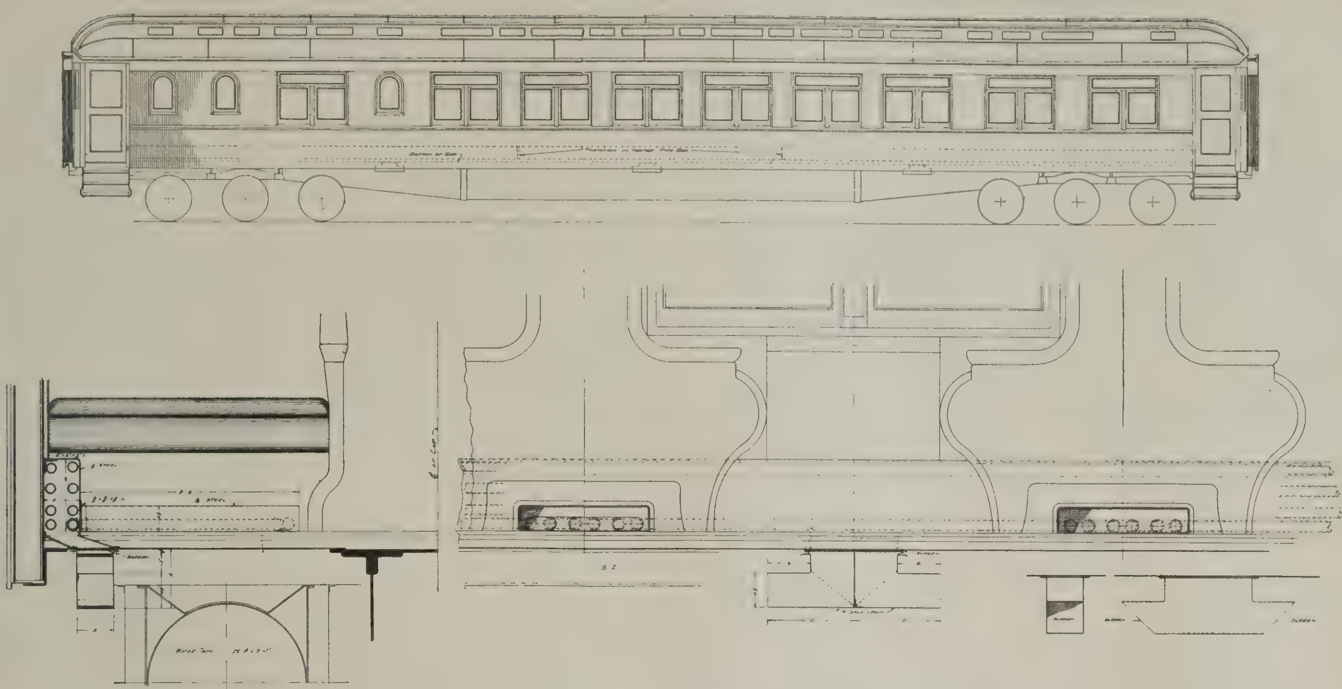
Provision may be made for introducing the fresh air by means of a series of intake openings having projecting faces below the side frame of the car body, and connected to a casing placed about the steam coils having outlet connections in the seat boxes to permit of the fresh air being introduced into the aisle space.

In the case of the standard Pullman car, connection may be made to the casing around the steam coils, having a vertical duct extending upward in the space between the windows and having outlets adjacent to the lamp brackets. This arrangement would insure a supply of air to the lower berths of the car, and the exhaust system in operation would provide for an absolute and constant disposal of the vitiated air rising from the lower level of the car.

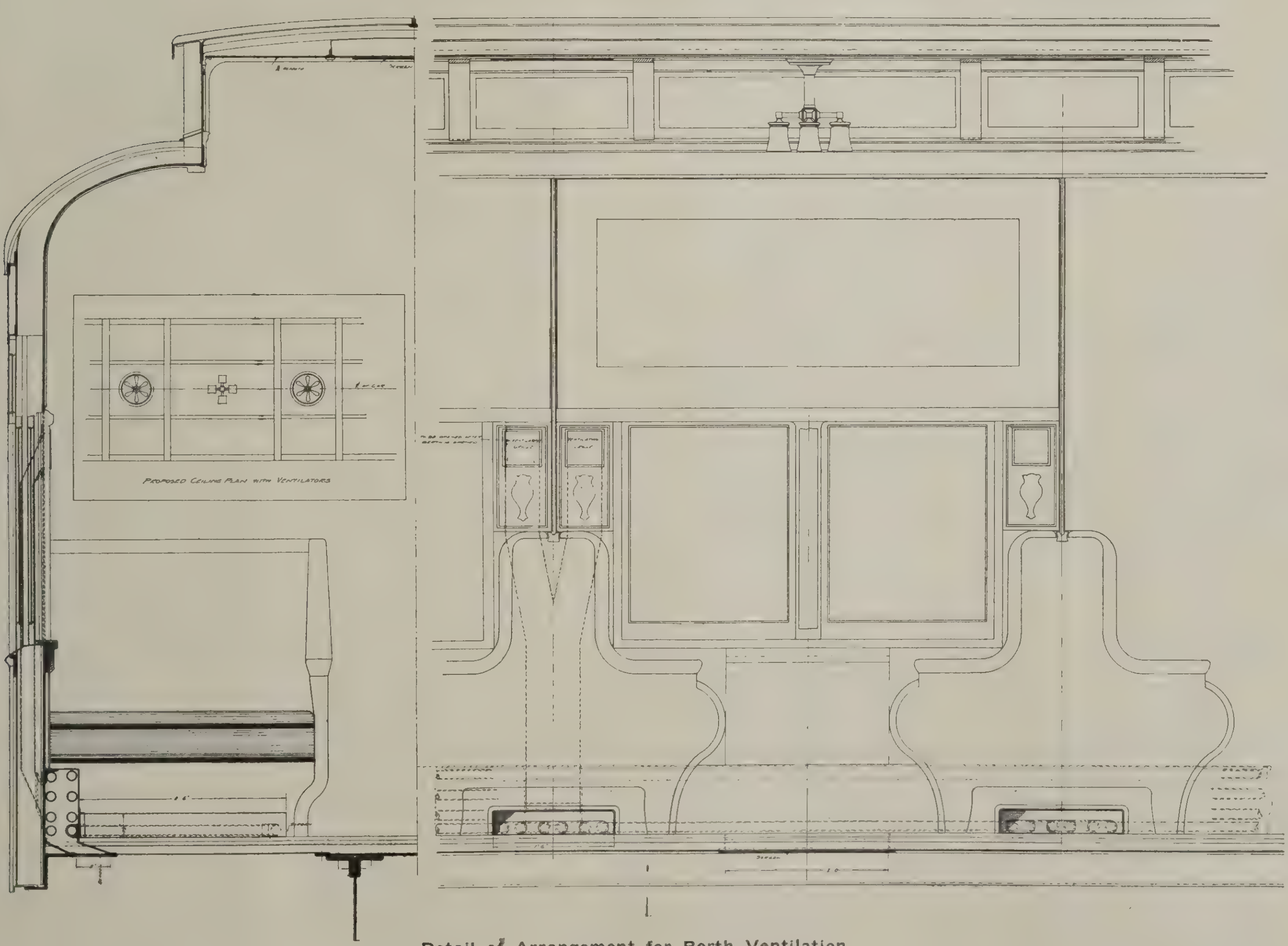
It does not seem that any system of car ventilation for steam cars will be considered adequate until proper provision has been made for the introduction of fresh air to replace the air exhausted at the roof level.

In case it is decided that a positive pressure system, forcing fresh air into the car, is superior to a vacuum exhaust system, the same installation could be used for that purpose by substituting a positive pressure blower for the exhaust fan and providing a suitable air intake. Or the fan could be connected so as to furnish air passing over the heating coils. So far the exhaust system has been thought preferable by most of those who have investigated the question.

The application of the system as outlined above would insure proper ventilation of cars standing in terminals, and would also provide for a thorough distribution of the heated air radiating from the steam coils. The system as described above is manufactured by the Vacuum Car Ventilating Company of Chicago under patents owned by them.



Vacuum Mechanical Ventilating System—Arrangement of Air Influx



Detail of Arrangement for Berth Ventilation.

A Study of the Ventilation of Sleeping Cars

By THOMAS F. CROWDER, M. D.

All air contains carbon-dioxid as a normal constituent. The average amount in pure air is commonly stated to be 4 parts in 10,000.

The carbon-dioxid in the expired breath averages more than 4 per cent. (400 in 10,000). The amount excreted hourly varies according to age, sex and the degree of bodily activity. In a mixed community of persons at rest it will average about 0.6 cu. ft. per person per hour.

If there were no ventilation whatever the air of an ordinary railway coach, containing 4,000 cu. ft. of space and occupied by 20 people, would have 34 parts of carbon-dioxid per 10,000 of air at the end of one hour. This would continue to increase indefinitely in a direct ratio to the time, since carbon-dioxid continues to a produced by the respiration of the occupants at a practically constant rate.

It is plainly impossible to measure directly the amount of air flowing into a car, since it enters at many points and at constantly changing velocities. But the amount of the interchange may be readily computed from the actual amount of carbon-dioxid found from time to time by applying the figures given above to a simple mathematical procedure. Suppose a car contains 20 people and its atmosphere is found to have an average of 10 parts of carbon-dioxid per 10,000. The incoming fresh air contains 4 parts, hence the respiratory contamination of the car air is represented by only 6 parts.

The 20 people produce 20 times 0.6 cu. ft., or 12 cu. ft. of carbon-dioxid per hour. With what amount of air must the 12 cu. ft. be diluted so that the air contain 6 parts of carbon-dioxid in 10,000? The simple proportion, 6 :10,000 : :12 :X gives 20,000 as the answer (or 1,000 cu. ft. per hour for each person present).

Some 15 or 20 years ago analyses of air from passenger cars were made by Prof. Nichols for the Board of Railroad Commissioners of Massachusetts. In 1894 a committee of the Master Car Builders' Association made a report on the subect of car ventilation and with it submitted the results of several analyses of air from cars, which are included in Table II.

In 1904 Mr. C. B. Dudley reported on analyses of the air of cars of the Pennsylvania Railroad, which were ventilated by the excellent system he devised. He found from 10 to 18 parts of carbon-dioxid per 10,000 in running cars, and from 20 to 21 in cars standing still for 20 minutes. The 52 people in each car are assumed to have produced 0.72 cu. ft. of carbon-dioxid each per hour; from which it is estimated 26,000 to 62,000 cu. ft. of air-supply per hour for the moving cars and 22,000 for the still cars.

Nearly 3,000 carbon-dioxid determinations were made for all purposes in connection with this work; about 2,000 of these were of the air of over 200 sleeping cars.

In order to test the consistency of the results obtained and to find if the carbon-dioxid actually does go up in proportion to the number of passengers, 555 observations were divided into four groups according to the number of passengers as shown in Table III. It is seen that it does increase with the number of passengers.

TABLE I.- RESULTS OF NUMEROUS TESTS TO DETERMINE THE CONDITION OF AIR IN SLEEPING CARS.

(Normal Carbon-dioxid in air;4 parts in 10,000)

(Cars with natural ventilation)	Ave.No. People in car.	Carbon-dioxid per 10,000 parts of air Ave.	Min.	Max.	Air to maintain Av. CO_2 cu.ft./hr.
1. Decks open;doors and windows closed.	15	7.19	3.5	13.0	28,300
2. Ditto,but doors open to vestibule.	10	5.40	3.5	8.5	40,700
3. All decks,doors and windows closed.	13	8.33	5.5	15.0	18,500
4. In lower berth.	16	8.32	5.0	18.0	1,389
5. In aisle opposite lower berth.	16	7.32	4.5	10.0	per berth
6. In upper berth.	21	9.17	4.5	18.5	1,161
7. In aisle opposite upper berth. (4-7;Windows and doors closed)	21	8.37	6.0	13.0	per berth
(Cars with Exhaust Ventilators)					
8. Decks open;doors and windows closed.	13	6.01	4.5	10.0	38,400
9. Ditto,for aisle only (night).	16	6.33	4.5	10.0	41,300
10. Doors open to vestibule.	14	5.50	3.5	9.0	57,900
11. In lower berth.	16	6.96	4.5	13.5	2,027
12. In aisle opposite lower berth.	16	6.33	4.5	10.0	per berth
13. In upper berth.	17	6.70	4.5	10.5	2,222
14. In aisle opposite upper berth. (11-14;Windows and doors closed)	17	5.95	4.5	9.5	per berth

TABLE II.-COMPARATIVE RESULTS OF TESTS OF CARBON-DIOXID IN AIR

Place	No. of Observations	Parts of CO_2 in 10,000 parts of air Aveerage	Maximum	Equiv. air per person cu.ft./hr.
Sleeping cars (body)	294	6.20	10.0	2,727
Sleeping cars (berths)	690	6.96	13.5	2,027
Day coaches (32 passengers)	43	9.38	21.0	1,100
Street cars	45	15.10	29.0	541
Elevated cars	17	13.80	26.5	674
Suburban coaches	47	14.30	38.0	583
Stores	25	8.80	10.0	1,250
Restaurants	51	16.10	26.0	496
Offices	26	13.91	19.0	670
Sleeping cars (12 pass.)		18.0	22.0	
Chair cars (17 pass.)		10.7	15.5	M.C.B. Report
Suburban cars (1/2 full)		13.8	21.7	

TABLE III.—RELATION OF AIR POLLUTION TO NUMBER OF PASSENGERS.

No. of Pass.	Carb. diox.; parts per 10,000 Cars with nat. vent.	Cars with exh. vent.
Under 10	5.91	5.58
10 to 15	6.62	5.95
15 to 20	7.38	6.46
Over 20	8.85	7.24
Average	6.88	6.11

*Extracts from a paper by Dr. Crowder, Superintendent of Sanitation, The Pullman Company, presented before the American Public Health Association in 1910.

Electrical Operation of the West Jersey & Seashore R. R.

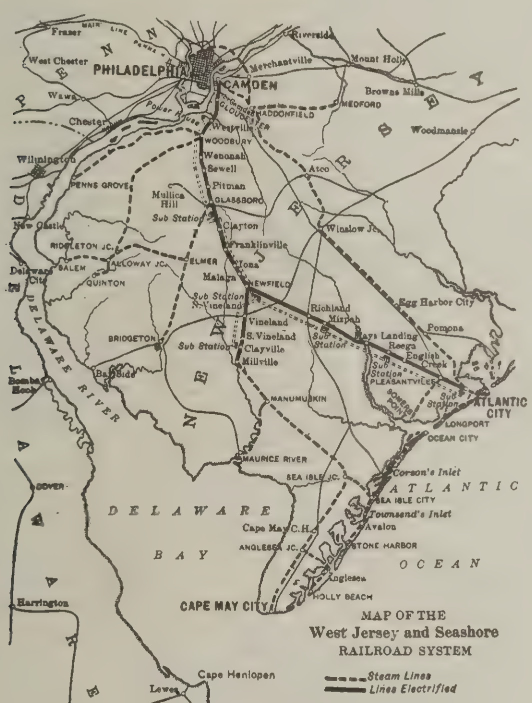
Detailed Cost of Operating an Electrified Railroad 75 Miles Long

By B. F. WOOD

It is the object of this paper to present data of the electrical operation of the West Jersey & Seashore Railroad taken direct from the operating records. No effort has been made to curtail or to modify in any respect the data selected. No attempt will be made to analyze or compare the data with any that have heretofore been presented.

This paper will be of value if railroad engineers are encouraged to present similar data, and if some standard form for the compilation of such data is agreed upon. Comparisons could then be made more readily and their value enhanced.

The portion of the line which is electrically operated extends from Camden, via Newfield, to Atlantic City, a distance of 64.6 miles; and from Newfield to Millville, a distance of 10 miles. With the exception of the



Map of West Jersey & Seashore Railroad.

Millville branch, which is a single track railroad, the line is double tracked, with a third track extending for a distance of about 6 miles north of Woodbury.

This portion of the W. J. & S. R. R. was originally operated by steam and was a single track line south of Newfield. Electrification was undertaken in 1905, and has progressed so that by the early part of 1906 the first train was moved electrically. Regular electric service was established in September of the same year.

The direct current over-running third-rail system operating at 675 volts was chosen. A map of the W. J. & S. R. R. is shown herewith from which the electrified portion can readily be followed. The location of the power station and sub-stations are shown as well as the position of the transmission line with respect to that of the railroad.

In order that the statements of cost of operation and detentions to train service may be more readily understood, the general characteristics of the electrified portion are given.

General Description.

Track:

Total length of single track including sidings—150 miles.

COST OF CONSTRUCTION

Power Stations:		
Building, stacks, coal and ash handling machinery	$354,000	
Equipment	640,900	
Total		$994,900
Transmission line		241,500
Substations:		
Buildings	72,000	
Equipment	419,560	
Total		491,560
Third rail		557,636
Overhead trolley		80,500
Track bonding		102,659
Cars		1,135,900
Car repair and inspection sheds		46,674
Right-of-way, additional		592,100
Reconstructing tracks		763,800
Constructing new tracks		2,071,000
Terminal facilities and changes at stations		252,400
Signals and interlocking plants		561,900
Changing telegraph and adding telephone facilities		105,100
Fencing right-of-way, cattle guards, etc.		88,400
Miscellaneous items		44,200
Total		8,130,229

UNIT COST OF ELECTRIFICATION

Power station, cost per kw	$110.00
Transmission line, cost per mile	3,485.00
Substations, building and equipment cost per kw	28.90
Third rail, cost per mile	4,235.00
Overhead trolley, cost per mile	4,120.00
Track bonding, cost per mile	684.50
Cars, including electrical equipment each	12,214.00

Power Station:

Located at Westville, N. J., 5.6 miles from Camden Terminal. Rated capacity 80000 kilowatts.

Transmission Line:

Length, 69.3 miles.

Line in duplicate, 33,000 volt Y connected, neutral grounded.

Wire, No. L. B. & S., hard drawn, solid copper.

Wires transposed by one complete spiral between each sub-station, making a total of seven transpositions.

Signal line and lighting circuit, 1100 volt single phase, runs below 33,000 volt line from Camden to Newfield and from Pleasantville to Atlantic City.

Substations:

The high-tension, three-phase current is reduced in

*From a paper by B. F. Wood before the A. I. E. E., Chicago, June 26, 1911.

pressure and converted to direct-current at 675 volts in substations located as shown on map.

Third Rail:

Total length of single rail, including 4.73 miles of sidings is 141.73 miles.

Third rail is standard P. R. R. cross section and composition, 100 lb. per yard. Located 2 ft. 2 in. from gauge line of track and 3½ in. higher than track rails. Top contact. No feeders are used in connection with the third rail.

Trolley:

Total miles length, including overlapping, 9.55.

Wire is No. 4/0 grooved section supported by ⅜ in. galvanized steel stranded span wires 22 feet above the rails.

Two 750,000 c. m. feeders South Camden substation to Haddon Ave., Camden, and one 500,000 c. m. cable, South Camden substation to South Gloucester.

TABLE I
WEST JERSEY & SEASHORE RAILROAD
Electric train service
Passenger train statistics
Cost of operation in cents per car mile
Year 1909

	Repairs, Electric Equipment of Cars.	Repairs Passenger Cars.	Other Maintenance of Equipment Costs.	Electric Power at Car Shoes.	Yard Service Shifting Costs	Motormen	Trainmen.	Train Supplies and Expenses.	Total.	Other Expenses	Total Expenses.	Car Miles, Total.	Average Cars per Train.
January	1.06	2.05	0.48	4.78	0.51	0.93	1.53	1.20	12.53	10.25	22.78	279,210	3.113
February	1.07	2.42	0.38	4.63	0.51	0.91	1.49	1.22	12.63	10.99	23.62	258,130	3.163
March	1.18	1.97	0.35	4.99	0.52	0.99	1.65	1.18	12.83	10.17	23.00	279,193	3.092
April	1.26	2.03	0.25	4.43	0.46	0.89	1.40	0.61	11.32	9.14	20.46	317,963	3.483
May	0.84	1.73	0.26	3.98	0.44	0.88	1.45	0.45	10.03	9.18	19.21	318,006	3.482
June	0.40	0.68	0.31	3.58	0.25	0.86	1.41	0.42	7.91	9.35	17.26	339,294	3.530
July	0.33	0.44	0.12	2.82	0.20	0.80	1.25	0.40	6.36	6.95	13.31	478,203	3.669
August	0.28	0.40	0.24	2.75	0.20	0.75	1.18	0.36	6.06	6.29	12.35	517,223	3.921
September	0.43	0.67	0.14	2.75	0.25	0.83	1.32	0.42	6.81	6.87	13.68	428,571	3.584
October	0.64	0.71	0.24	3.84	0.31	0.92	1.53	0.62	8.81	10.21	19.02	307,825	3.046
November	0.52	0.39	0.29	3.85	0.29	0.95	1.70	0.82	8.81	9.30	18.15	291,816	3.327
December	0.87	1.08	0.29	12.31	0.30	1.00	1.72	1.30	18.87	15.05	33.92	292,175	3.318
Avg. per mo.	0.68	1.10	0.25	4.30	0.33	0.88	1.44	0.69	9.67	9.08	18.75	4,107,609	3.457
Year 1910													
January	0.86	1.03	0.67	4.59	0.46	0.96	1.64	2.24	12.45	7.22	19.67	292,523	3.169
February	0.79	1.78	0.33	5.38	0.50	0.97	1.48	1.07	12.30	12.44	24.74	262,488	3.137
March	1.04	1.13	0.28	3.87	0.48	0.88	1.51	0.89	10.08	12.91	22.99	333,252	3.445
April	0.62	0.76	0.31	4.57	0.49	0.97	1.62	0.70	10.04	11.55	21.59	302,463	3.344
May	0.57	0.78	0.24	2.78	0.48	0.89	1.41	0.44	7.59	9.92	17.51	351,994	3.651
June	0.79	0.67	0.24	2.80	0.45	0.97	1.62	0.58	8.12	10.13	18.25	375,023	3.406
July	0.44	0.46	0.18	2.47	0.34	0.89	1.39	0.36	6.53	6.66	13.19	565,787	3.641
August	0.29	0.57	0.15	2.48	0.33	0.85	1.38	0.37	6.42	5.62	12.04	594,852	3.811
September	0.37	0.54	0.21	2.71	0.39	0.85	1.42	0.42	6.91	7.34	14.25	487,543	3.771
October	0.73	1.19	0.28	3.05	0.47	0.91	1.69	0.52	8.84	12.34	21.18	339,789	3.564
November	1.40	2.45	0.47	3.71	0.51	0.96	1.71	0.54	11.75	10.58	22.33	311,882	3.379
December	0.63	1.94	0.21	3.93	0.51	0.93	1.71	0.74	10.60	12.13	22.73	334,936	3.494
Avg. per mo.	0.66	1.01	0.27	3.33	0.43	0.91	1.52	0.67	8.80	9.39	18.19	4,552,532	3.518

TABLE III
WEST JERSEY & SEASHORE RAILROAD ELECTRIC TRAIN SERVICE
Cost of maintenance of transmission systems
Year 1910

	High tension		Overhead trolley		Third rail		Running track bonding	
	Total	Per mile	Total	Per mile	Total	Per mile	Total	Per mile
January	$142.96	$2.04	$690.84	$35.32	$492.96	$2.74	$26.67	$1.51
February	409.74	5.85	266.38	13.62	580.80	4.41	562.82	3.75
March	198.62	2.84	381.28	19.49	495.55	3.76	39.26	0.26
April	403.44	5.76	446.57	46.71	745.16	5.26	30.24	0.20
May	256.14	3.66	291.51	30.49	1,126.40	7.95	190.05	1.27
June	123.21	1.76	864.62	90.44	957.42	6.75	312.08	2.08
July	167.90	2.40	393.62	41.17	818.29	5.77	494.79	3.30
August	357.20	5.10	317.49	33.21	1,631.72	11.51	32.99	0.22
September	508.51	7.26	389.73	40.77	838.87	5.92	202.05	1.35
October	604.93	8.64	245.75	25.70	647.27	4.57	98.66	0.66
November	171.58	2.45	363.35	38.01	11,062.98	7.50	189.83	1.26
December	100.34	1.43	244.02	25.52	1,466.71	10.35	125.03	.0.83
Year	3,444.57	4.10	4,895.16	36.70	10,864.13	6.46	2,445.72	1.36

†Credit for scrap 58.75

TABLE IV
WEST JERSEY & SEASHORE RAILROAD ELECTRIC TRAIN SERVICE
Cost of operation and maintenance of substations
Year 1910

	Total for eight substations				
	Operation	Maintenance	Total	Cost per kw-hr.	Substation output kw-hr. 675 volts direct-current
January	$1,573.82	$373.10	$1,946.92	$0.001136	1,655,800
February	*1,601.78	147.39	1,749.17	0.001157	1,460,200
March	1,618.16	174.27	1,792.43	0.001035	1,678,400
April	1,728.98	275.64	2,004.62	0.001251	1,554,900
May	1,760.46	370.91	2,131.37	0.001267	1,635,900
June	1,794.44	432.55	2,226.99	0.001310	1,655,600
July	2,006.97	317.62	2,324.59	0.001047	2,175,700
August	1,751.03	194.13	1,945.16	0.000811	2,349,000
September	†1,776.14	903.45	2,679.59	0.001285	2,035,200
October	1,744.23	145.99	1,890.22	0.001069	1,712,100
November	1,750.62	142.23	1,892.85	0.000986	1,860,100
December	1,745.68	130.02	1,875.70	0.000829	2,199,400
Year	$20,852.31	$3,607.30	$24,459.61	$0.001082	$21,972,300

TABLE II
WEST JERSEY AND SEASHORE RAILROAD
ELECTRIC TRAIN SERVICE
COST OF OPERATION AND MAINTENANCE OF WESTVILLE POWER STATION
YEAR 1910

Items	January Total	January Cents per kw-hr	February Total	February Cents per kw-hr	March Total	March Cents per kw-hr	April Total	April Cents per kw-hr	May Total	May Cents per kw-hr	June Total	June Cents per kw-hr
OPERATION — Labor — Boiler room	1,069.73	0.050	1,073.82	0.058	1,153.75	0.053	1,289.69	0.064	1,189.43	0.056	1,187.22	0.055
Turbine	803.50	0.038	806.95	0.043	771.83	0.036	828.21	0.041	854.00	0.040	795.88	0.037
Electrical	133.69	0.006	135.18	0.007	131.53	0.006	140.37	0.007	142.71	0.007	138.75	0.006
Supervision janitors and watchmen	431.09	0.020	388.56	0.021	371.13	0.017	188.13	0.002	169.83	0.008	164.15	0.007
Total operating labor	2,438.10	0.114	2,404.51	0.129	2,428.24	0.112	2,446.30	0.121	2,335.97	0.111	2,286.00	0.105
Material — Coal	7,725.33	0.363	7,049.28	0.378	7,769.57	0.358	7,169.62	0.353	7,575.21	0.358	8,262.96	0.381
Water	41.67	0.002	41.67	0.002	41.68	0.002	41.67	0.002	41.66	0.002	41.65	0.002
Lubricants									40.72	0.002	38.27	0.002
Misc. material	204.62	0.010	121.51	0.007	234.71	0.011	137.25	0.007	75.38	0.004	78.33	0.004
Misc. charges	123.10	0.005	120.88	0.006	112.40	0.005	116.80	0.005	144.49	0.007	172.80	0.008
Total operating material	8,094.72	0.380	7,333.34	0.393	8,156.36	0.378	7,485.34	0.367	7,877.45	0.373	8,594.01	0.397
Total operation	10,532.82	0.494	9,737.85	0.522	10,586.60	0.488	9,911.84	0.488	10,233.42	0.481	10,880.01	0.502
MAINTENANCE — Labor — Building	13.04	0.001	4.91	0.000	4.41	0.000	67.21	0.003	45.20	0.002	31.69	0.001
Boiler room	79.67	0.004	148.68	0.008	191.89	0.009	220.67	0.011	159.36	0.008	82.21	0.004
Turbine	32.13	0.001	48.48	0.003	118.85	0.005	30.66	0.001	29.64	0.001	97.10	0.004
Auxiliary apparatus	39.74	0.002	43.22	0.003	33.71	0.002	31.44	0.001	33.22	0.002	189.25	0.009
Electrical	0.56	0.000	4.95	0.000	13.57	0.001	15.92	0.001			15.46	0.001
Piping	35.74	0.001	39.47	0.002	48.03	0.002	75.02	0.004	72.23	0.003	70.83	0.003
Miscellaneous	38.49	0.002					13.68	0.001	34.11	0.002	65.84	0.003
Total maintenance labor	237.37	0.011	289.71	0.016	410.46	0.019	452.60	0.022	373.76	0.018	532.58	0.025
Material — Building	6.26	0.000	3.63	0.000	10.76	0.001	42.01	0.002	44.92	0.002	13.81	0.001
Boiler room	145.62	0.007	304.04	0.016	249.03	0.012	231.07	0.011	89.60	0.004	196.62	0.003
Turbine	3.19	0.000	125.41	0.007	363.53	0.017	440.23	0.022	88.04	0.004	25.15	0.001
Auxiliary apparatus	26.35	0.001	144.10	0.008	43.30	0.002	58.26	0.003	67.66	0.003	264.32	0.012
Electrical	0.60	0.000	6.74	0.000	4.82	0.000			3.12	0.000	83.79	0.004
Piping	9.96	0.001	21.97	0.001	31.81	0.001	52.29	0.003	12.16	0.001	42.66	0.002
Miscellaneous			52.97	0.003	49.21	0.002	40.67	0.002			87.87	0.004
Total maintenance material	193.96	0.009	652.86	0.035	752.46	0.035	864.53	0.043	305.50	0.014	714.22	0.033
Total maintenance	431.35	0.020	942.57	0.051	1,162.92	0.054	1,317.13	0.065	679.26	0.032	1,266.80	0.058
SUMMARY — Total labor	2,675.47	0.125	2,694.22	0.145	2,838.70	0.131	2,898.90	0.143	2,729.73	0.129	2,838.58	0.130
Total material	8,288.70	0.389	7,986.20	0.428	8,910.82	0.411	8,329.87	0.410	8,182.95	0.387	9,308.23	0.430
Total labor and material station proper	10,964.17	0.514	10,680.42	0.573	11,749.52	0.542	11,228.77	0.553	10,912.68	0.516	12,146.81	0.560
Other items charged to station accounts	143.83	0.007	144.86	0.007	137.83	0.006	192.62	0.009	197.62	0.009	174.49	0.008
Total	11,108.00	0.521	10,825.28	0.580	11,887.35	0.548	11,421.30	0.562	11,110.30	0.525	12,321.30	0.568
Net output	2,131,000		1,865,300		2,168,600		2,031,400		2,115,900		2,167,500	
Lbs. coal per kw-hr	3.311		3.46		3.27		3.223		3.269		3.14	
Cost of coal per 2000 lbs	$2.19		$2.19		$2.19		$2.19		$2.19		$2.42	

Items	July Total	July Cents per kw-hr	August Total	August Cents per kw-hr	September Total	September Cents per kw-hr	October Total	October Cents per kw-hr	November Total	November Cents per kw-hr	December Total	December Cents per kw-hr	Year Total	Year Cent per kw-hr
OPERATION — Labor — Boiler room	1,314.53	0.047	1,386.02	0.045	1,319.78	0.051	1,239.95	0.056	1,324.86	0.052	1,293.66	0.047	14,742.38	0.052
Turbine	857.18	0.031	835.60	0.028	866.82	0.033	866.06	0.039	861.18	0.036	843.42	0.031	10,010.81	0.035
Electrical	141.89	0.005	138.10	0.004	135.46	0.003	139.48	0.006	140.89	0.006	142.97	0.005	1,661.02	0.006
Supervision janitors and watchmen	181.30	0.007	171.67	0.006	176.60	0.007	179.14	0.008	166.53	0.007	168.20	0.006	2,756.23	0.010
Total operating labor	2,494.82	0.090	2,351.48	0.083	2,408.66	0.026	2,424.63	0.103	2,393.46	0.101	2,448.25	0.089	29,170.42	0.103
Material — Coal	9,849.62	0.354	10,378.06	0.341	9,392.80	0.370	7,908.66	0.355	8,770.38	0.368	10,463.82	0.379	102,715.31	0.363
Water	41.67	0.001	41.68	0.001	41.68	0.002	41.66	0.002	41.66	0.002	41.65	0.002	500.00	0.002
Lubricants	47.37	0.002	101.21	0.003	25.74	0.001	35.63	0.001	40.05	0.001	75.92	0.003		
Misc. material	147.62	0.005	131.95	0.004	167.39	0.007	169.71	0.008	156.81	0.007	208.25	0.007	2,238.44	0.007
Misc. charges	124.60	0.004	213.98	0.007	230.77	0.009	127.00	0.006	117.33	0.005	96.35	0.003	1,700.49	0.006
Total operating material	10,210.88	0.366	11,066.88	0.358	10,058.38	0.389	8,282.66	0.372	9,126.23	0.383	10,885.99	0.394	107,154.24	0.378
Total operation	12,705.70	0.456	13,618.36	0.441	12,557.04	0.485	10,707.29	0.481	11,519.69	0.484	13,334.24	0.483	136,324.66	0.481
MAINTENANCE — Labor — Building	8.06	0.000	14.02	0.000	38.29	0.002	20.54	0.001	37.35	0.002	21.15	0.001	326.29	0.001
Boiler room	104.55	0.004	127.66	0.004	129.76	0.003	97.50	0.004	121.98	0.005	86.71	0.003	1,550.44	0.005
Turbine	32.75	0.002	10.96	0.000	22.57	0.001	51.40	0.002	47.35	0.002	294.22	0.011	836.11	0.003
Auxiliary apparatus	84.34	0.003	174.36	0.006	49.20	0.002	23.06	0.001	134.89	0.006	8.74	0.000	844.17	0.003
Electrical	75.56	0.003	26.21	0.001	21.53	0.001	4.47	0.000	10.15	0.000	6.92	0.000	195.30	0.001
Piping	66.10	0.002	75.10	0.001	52.34	0.002	57.25	0.003	57.07	0.002	44.76	0.002	891.94	0.002
Miscellaneous					20.66	0.001	16.52	0.001					187.30	0.001
Total maintenance labor	391.18	0.014	428.31	0.014	354.35	0.014	269.74	0.012	408.99	0.017	462.50	0.017	4,831.55	0.016
Material — Building	1.74	0.000	1.71	0.000	10.87	0.000			5.17	0.000	3.75	0.000	146.63	0.001
Boiler room	68.01	0.003	109.73	0.004	148.02	0.006	548.11	0.025	170.24	0.007	235.14	0.009	2,493.23	0.009
Turbine	24.05	0.001	76.86	0.002	67.58	0.002	361.11	0.016	8.08	0.001	14.29	0.000	1,597.52	0.006
Auxiliary apparatus	8.78	0.000	1,332.58	0.043	22.69	0.001	28.81	0.001	19.48	0.001	67.36	0.003	2,066.13	0.007
Electrical	2,924.13	0.103	0.85	0.000	13.02	0.000	6.74	0.000	0.14	0.000	8.50	0.000	3,046.44	0.011
Piping	9.74	0.000	10.66	0.000	40.02	0.002	106.49	0.005	24.73	0.001	21.48	0.001	383.97	0.001
Miscellaneous	84.46	0.003									283.88	0.010	599.06	0.002
Total maintenance material	3,103.34	0.112	1,532.39	0.049	302.20	0.011	1,049.26	0.047	227.84	0.010	634.40	0.023	10,332.98	0.037
Total maintenance	3,494.52	0.126	1,960.70	0.063	656.55	0.025	1,319.00	0.059	636.83	0.027	1,096.90	0.040	14,964.53	0.053
SUMMARY — Total labor	2,886.00	0.104	2,979.79	0.097	2,853.01	0.110	2,694.37	0.121	2,802.45	0.118	2,910.75	0.106	33,801.97	0.119
Total material	13,314.22	0.478	12,599.27	0.407	10,360.58	0.400	9,331.92	0.419	9,354.07	0.393	11,520.39	0.417	117,487.22	0.415
Total labor and material station proper	16,200.22	0.582	15,579.06	0.504	13,213.59	0.510	12,026.29	0.540	12,156.52	0.511	14,431.14	0.523	151,289.19	0.534
Other items charged to station accounts	189.88	0.007	199.84	0.007	184.06	0.007	182.68	0.008	199.52	0.008	213.37	0.008	2,160.60	0.008
Total	16,390.10	0.589	15,778.90	0.511	13,397.65	0.517	12,208.97	0.548	12,356.04	0.519	14,644.51	0.531	153,449.79	0.542
Net output	2,781,300		3,088,300		2,590,400		2,229,000		2,381,500		2,759,300		28,312,500	
Lbs. coal per kw-hr	3.16		3.058		3.306		3.168		3.288		3.386		3.246	
Cost of coal per 2000 lbs	$2.24		$2.24		$2.24		$2.24		$2.24		$2.24		$2.235	

Cars and Equipment:

79 Coaches, each seating 58 passengers, weighting 94,500 lbs., or 1,630 lbs. per passenger. 2 Passenger and Baggage cars, seating 36. 6 Bagagge and Mail cars. 6 Baggage cars. Total, 93 cars.

Electrical equipment of each car: two 200 h. p. motors with multiple unit system of automatic control. Gear ratio 46:29.

Additional equipment authorized: 15 steel coaches, seating 72.

Construction and Operating Costs.

The accompanying table shows the cost of electrification construction and includes costs made necessary by electrification.

The organization of the operating department was not changed but was expanded to provide for the new duties.

Table I shows the cost of operation in cents per car mile for the years 1909 and 1910.

Table II shows the cost of operation of the Westville power station for 1910. These costs are carefully distributed under various headings.

Table III shows the cost of maintenance of the transmission system, trolley, third rail and rail bonding, for the year 1910.

Table IV shows the cost of operation and maintenance of the eight sub-stations.

Table V shows the train detentions from various causes in 1909. It will be noted that less than 8 per cent of these were due to electrical operation.

Table VI gives general power data for the years 1907 to 1910 inclusive. It will be noted that there has been a steady reduction in the cost of power, it being, for the year 1910, only a trifle over half a cent per kilowatt-hour.

TABLE V

WEST JERSEY & SEASHORE RAILROAD ELECTRIC TRAIN SERVICE

Detentions

Year 1909

Causes	Train detentions, number, time and per cent for various causes				
	Number of detentions		Minutes detention		
	Total	Per cent of total	Total	Per cent of total	Car miles per minute detention
Transportation.					
Boat connection	51	0.553	180	0.403	22,815.36
Baggage, express and mail	1898	20.575	8373	18.749	490.47
Heavy travel	1232	13.355	4612	10.328	890.45
Collecting tickets	72	0.781	334	0.748	12,295.70
Train connections	977	10.591	5517	12.354	744.38
Traffic ahead	1723	18.677	7842	17.561	523.68
Held at signal	1390	15.068	4767	10.675	861.50
Stops on order	73	0.791	165	0.369	24,889.49
Fast schedule	34	0.368	57	0.128	72,048.50
Picking up and cutting off cars.	411	4.455	1312	2.938	3,130.15
Fog	41	0.444	127	0.284	32,336.73
Signal failure	208	2.255	860	1.926	4,775.31
Accidents	26	0.282	261	0.584	15,734.73
Obstructions	33	0.358	194	0.434	21,168.89
Miscellaneous	283	3.068	1427	3.196	2,877.90
Total transportation	4852	91.621	36028	80.677	113.98
Motive power.					
Power house trouble	15	0.163	69	0.155	59,518.30
High tension line trouble	14	0.152	81	0.181	50,700.80
Lightning	12	0.130	47	0.105	87,377.90
Overloads in substations	11	0.119	61	0.137	67,324.00
Third rail shorts	3	0.032	14	0.031	293,340.40
Third rail out of place	1	0.011	8	0.019	513,345.13
Third rail anchor on fire	1	0.011	5	0.011	821,353.00
Third rail protection out of place	1	0.011	1	0.002	4,106,765.00
Trolley wire trouble	253	2.742	1920	4.299	2,138.94
Train equipment	237	2.569	1568	3.511	2,619.11
Total motive power	548	5.940	3774	8.451	1,088.17
Weather Conditions.					
Snow, head winds, wet rail	178	1.929	4043	9.054	1,015.77
Sleet on third rail	47	0.510	812	1.818	5,057.59
Total weather condition	225	2.439	4855	10.872	845.88
Grand total	9225	100.00	44657	100.00	91.26

Total car mileage 4,106,765

Car miles per detention 445.18

Car miles per minute of detention 91.96

TABLE XI

WEST JERSEY & SEASHORE RAILROAD ELECTRIC TRAIN SERVICE

General power data

	1907				1908			
	Alternating Current kw-hr Power Station Output	Cost in Mills per Kw-hr. Output	Lb. of Coal Kw-hr. Output	Efficiency Power Sta. Bus to Substation Bus	Alternating Current Kw-hr. Power Station Output	Cost in Mills per Kw-hr. Output	Lb. of Coal Kw-hr. Output	Efficiency Power Sta. Bus to Substation Bus
January	1,911,600	8.83	3.91	72.6	2,009,600	6.10	3.49	73.3
February	1,691,500	7.95	3.63	74.5	1,913,100	6.35	3.55	73.6
March	1,583,000	7.76	3.96	71.5	1,873,300	6.17	3.46	72 3
April	1,464,300	7.43	3.95	74.0	1,836,200	5.86	3.45	71.8
May	1,400,400	6.81	3.53	72.1	1,744,900	6.06	3.40	69.6
June	1,395,700	7.65	3.98	70.6	1,707,500	5.91	3.52	74.8
July	1,938,100	6.05	3.65	71.6	2,104,300	5.43	3.37	75.6
August	2,082,000	6.00	3.43	71.6	2,268,000	5.43	3.18	75.8
September	1,855,300	6.07	3.46	71.7	1,849,200	5.76	3.18	74.7
October	1,849,800	5.99	3.53	82.8	1,786,700	5.78	3.25	72.8
November	1,893,600	5.86	3.51	71.3	1,802,000	5.78	3.35	74.7
December	2,053,600	6.00	3.51	72.5	1,993,000	5.80	3.25	76.2
Av. for year	1,759,900	6.80	3.67	72.2	1,907,300	5.92	3.37	73.8
	1909				1910			
January	1,959,700	5.67	3.23	76.1	2,131,000	5.15	3.31	81.8
February	1,756,500	5.71	3.25	76.1	1,865,300	5.73	3.46	82.4
March	1,903,600	6.04	3.33	76.1	2,168,600	5.42	3.27	81.3
April	1,869,300	5.90	3.27	75.0	2,031,400	5.62	3.22	80.1
May	1,788,800	5.65	3.26	75.5	2,115,900	5.25	3.27	79.5
June	1,749,200	5.77	3.22	77.7	2,167,500	5.68	3.14	80.3
July	2,426,000	5.21	3.25	78.0	2,784,300	5.88	3.16	82.5
August	2,324,400	5.27	3.34	81.5	3,088,300	5.11	3.06	80.7
September	2,056,100	5.28	3.34	80.3	2,590,400	5.17	3.31	82.9
October	1,836,600	5.40	3.27	80.1	2,229,000	5.48	3.17	80.8
November	1,869,500	5.49	3.41	80.7	2,381,500	5.19	3.29	81.9
December	2,154,800	5.42	3.41	81.0	2,759,300	5.31	2.39	83.4
Av. for year	1,962,600	5.55	3.30	78.4	2,359,400	5.42	3.25	81.6

MR. KATTE'S REMARKS BEFORE THE A. I. E. E.

Our report of the remarks of Mr. E. B. Katte, which formed part of the discussion on electric traction at the annual convention of the A. I. E. E. in Chicago, seems to have been in error some respects. We are pleased to give space to the following corrected version:

"Mr. Katte highly commended the paper of Mr. Wood, but regretted the lack of comparative data between steam and electric operation. He called attention to the fact that according to the figures in Mr. Wood's paper the cost per mile for maintaining their trolley system was six times greater than that of their Third rail system. In discussing Mr. Murray's paper he noted that the train detentions given by Mr. Murary for the last six months of 1908 was 10,373 minutes as compared with 250 minutes for the same period on the New York Central direct current system. Mr. Katte said that the impression derived from the unit cost given in Mr. Murray's paper that the direct current system would be considerably less expensive, and this impression is in a way substantiated by comparison of the estimates submitted last fall to the joint Metropolitan Committee in Boston by the New Haven Company for single phase and by the New York Central for direct current electrification, where-in their average cost for single phase electrification was $71,000 and for direct current $59,000, including all items entering into the first cost of the change of motive power."

SHOP SECTION
EDITED BY
GEO. W. CRAVENS

Shop Series IV.---Illinois Central Railway

The principal shops of the I. C. Ry. are located at Chicago, Ill., in the suburb of Burnside. This lies in the southern portion of the city near the suburb of Pullman, and the shops lie along and to the west of the main line of the railroad. The grounds measure one-half mile in each direction with the buildings in a compact mass near the center.

The buildings form two groups lying respectively north and south of a center line composed of oil, storage and boiler houses. The locomotive department buildings compose the south group and the car department buildings the north group, the general arrangement being very logical. The magnitude of the freight traffic is indicated by the space allotted to freight car repairs.

The electrification of these shops has been very recently begun and rapid progress is being made. A large share, probably over 95 per cent, of the machine tools are driven in groups from line shafting, most of which is steam engine driven. Several of the larger machines have individual motors and a large number of new motors have recently been purchased and are being installed. Most of the leading manufacturers are represented. The old motors are 250-volt d. c. machines and the new ones operate on a 440-volt a. c. circuit. It is the present policy to use alternating current for all extensions. The present lighting is at 110 volts continuous current.

Power Plant and Distribution System.

The power generating equipment at the Burnside shops is not concentrated in one building, as is usually the case, but is distributed among four buildings. Two of these are the boiler houses at the west end of the row of buildings between the two main groups.

The larger of these boiler houses contains 8 Erie City boilers and the other 6 Aultman-Taylor boilers. They are arranged in pairs and all except one are hand fired. This one is equipped with a stoker and chain grate, but the hopper is hand filled. From these two buildings steam for power and heat is piped underground to all parts of the shops.

There are two engine rooms so located as to handle the heaviest loads direct with steam engines. One of these is alongside the locomotive machine shop and contains a large engine for driving the shop, and five generators driven by small engines. These comprise the following:

Four Steam Engines: one 180-h. p., one 100-h. p., 80-h.p., one 25-h. p.

Two Western Electric 250-volt generators for incandescent lighting, one of 300-amp. and the other of 115-amp. capacity.

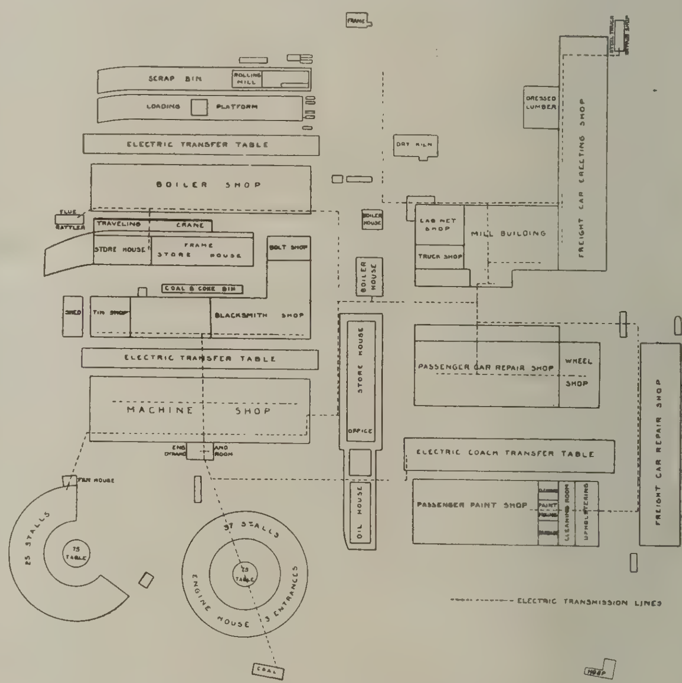
Two Western Electric 80-light arc generators.

One General Electric 30-light arc generator.

Both rope drive and belts are used in this engine room for power transmission, the ropes being part of the shop drive.

The other engine room is located adjacent to the planing mill and contains two Westinghouse 200 k. w. 250-volt generators with engines, two large air compressors and a large steam engine. The latter drives all woodworking machinery. The switchboard in this room consists of 9 black slate panels, controling the generators and feeder circuits. The pumps are in a separate building just west of the boiler houses.

The electrical distribution is by weatherproof wires carried overhead on wood poles. In several places the wires follow the buildings on brackets, and a short piece runs underground to the coal chutes. The present system is all 250 volts for power and 125 volts



Layout of Illinois Central Railroad Shops.

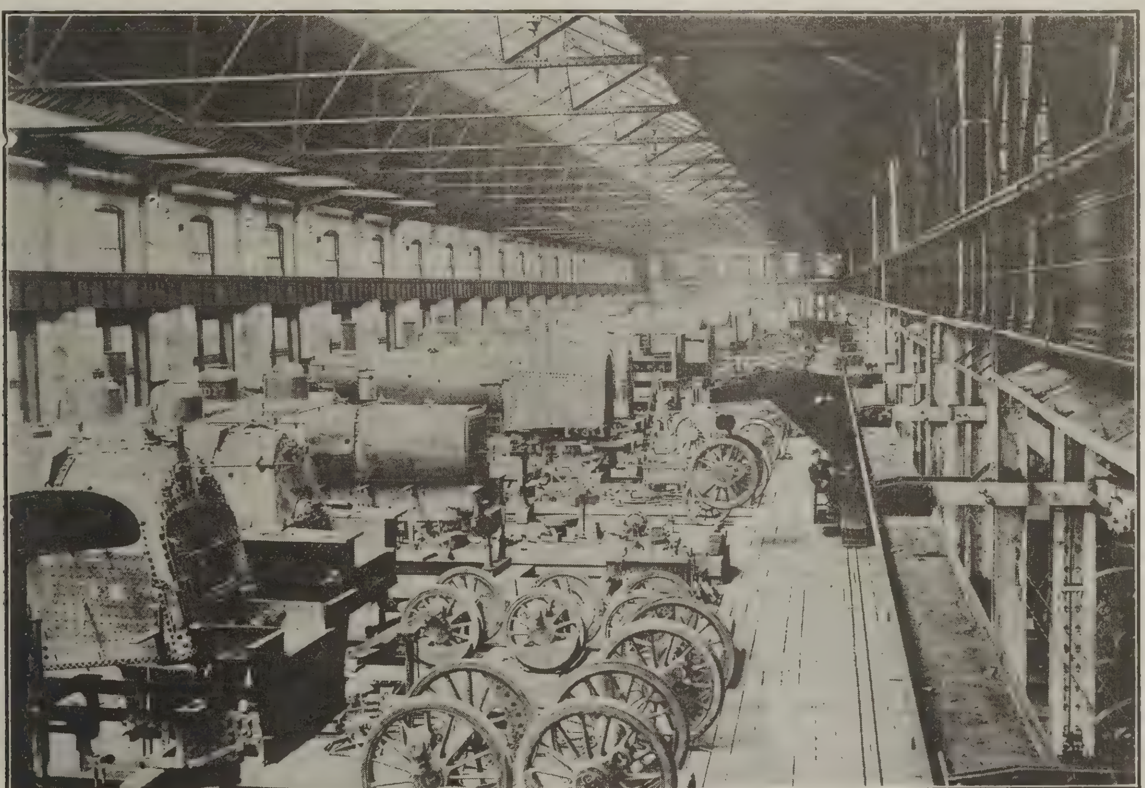
for incandescent lighting; the new distribution will be at 440 volts, three-phase alternating current. For the latter purpose a turbo-generator is being installed in the power house at the planing mill. This is a 500-k. v. a., 60-cycle outfit. A new transmission line will be installed to go with it.

Locomotive Shop.

The locomotive department occupies three large buildings and several small ones, of which the locomotive machine shop is the largest. This is at the east end of the south group of buildings, is 160 ft. wide by 550 ft. long and is in two sections, one containing 25 pits for locomotive erection and repairs and the other containing machine tools. In the latter section there are galleries along each side connected by bridges at intervals. Small tools and assembling benches are located here. Skylights run full length along the center of each bay and small skylights are placed at frequent intervals along the sides of the roofs. These, together with a lavish use of whitewash, make this one of the best lighted shops in the country.

The shop office and the main tool room are located about the center of the machinery bay, thus placing them to the best advantage. There are several freight elevators running up to the galleries, all of which are of the hydraulic plunger type. In the machinery bay several small jib cranes are installed, being attached to the steel columns and swinging so as to serve machine tools within a radius of twelve feet. In the erecting bay there is a large overhead crane with two hoisting trolleys of sufficient capacity to hoist any locomotive that may be brought into the shop. There is also a mono-rail crane here which runs along near the columns between the two sections and serves the erecting floor.

With the exception of a few large tools all of the machinery is group driven from line shafts operated by the steam engine in the adjacent engine room. As fast as possible the new motors previously mentioned will be installed here and more of the tools individually driven by induction motors. Steel lockers are provided for the men in order that their clothes and other property will be well protected, and reels of fire hose are placed at frequent intervals about the shop and connected to the water mains. Large hot air pipes are carried overhead for heating, the air being forced over coils of steam heated pipe by motor-driven fans. The lighting is done by arc lamps for the general illumination and by carbon incandescent lamps for local illumination. Just west of the locomotive shop and between it and the blacksmith shop is a motor-driven transfer 50 ft. wide by 590 ft. long with two trolley wires overhead.



Illinois Central Shops—Erecting Room in Locomotive Shop.

TABLE NO. 1—LOCOMOTIVE SHOP TOOLS.

MACHINE SHOP.

Engine Lathes.

1	14-inch.	3	26-inch.
3	16-inch.	4	30-inch.
1	18-inch.	3	32-inch.
7	20-inch.	4	36-inch.
1	22-inch.	1	40-inch.
2	24-inch.	1	42-inch.

Wheel Lathes.

1	100-inch.	1	90-inch.
2	75-inch.	1	Car wheel.

Turret Lathes.

6	24-inch.	2	16-inch.
3	20-inch.	1	14-inch.

Miscellaneous Lathes.

1	14-inch.	7	20-inch.
7	16-inch.	1	44-inch.
7	18-inch.	1	Truck axle.

Planers.

1	4-head, 36x36 ins. x 12 ft.	5	2-head, 36x36 ins. x 12 ft.
1	2-head, 72x84 ins. x 12 ft.	2	2-head, 30x30 ins. x 12 ft.
1	2-head, 60x60 ins. x 22 ft.	7	1-head, small sizes.
2	2-head, 48x48 ins. x 18 ft.		

Drill Presses.

11	42-inch.	3	18-inch.
3	36-inch.	2	6-inch radial.
1	32-inch	1	5-inch radial.
2	30-inch.	3	4-inch radial.
1	26-inch.	1	Multiple.
1	20-inch.		

Boring Mills.

2	51-inch.	3	36-inch.
2	48-inch.	1	30-inch.
4	42-inch.	1	28-inch.

4	26-inch shapers.	4	Presses.
4	Small shapers.	18	Grinders.
5	Slotters.	3	Saws.
6	Milling machines.	9	Miscellaneous small tools.
4	Bolt cutters.		

WHEEL SHOP.

2	42-inch car wheel lathes.	2	Drill presses.
5	42-inch boring mills.	3	Wheel presses.
10	Axle lathes.		

The Boiler Shop lies west of the blacksmith shop and fills a building 120 ft. wide by 550 ft. long. This building is also divided into two sections or bays, one of which is devoted to machinery and the other containing 23 pits for repair and erection work. There is

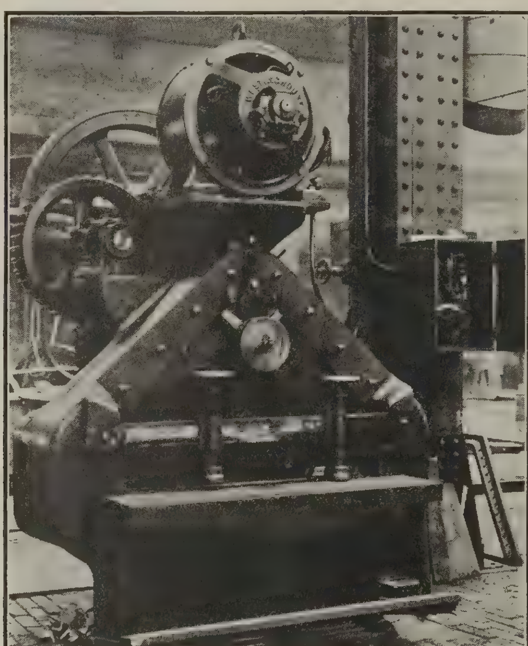
an overhead crane in each section and all machine tools are group driven from line shafts excepting a few of the larger ones. The two line shafts are each driven by a 50-h. p., 250-v. d. c. motor, and the building is lighted by large skylights during the day. For artificial lighting 36 arc lamps and 72 incandescents have been provided. Some of the new a. c. motors will also be installed here. This building is also heated with hot air similar to the locomotive machine shop, and a transfer of the same kind runs along the west side of the building.

TABLE III—BLACKSMITH SHOP TOOLS.

2 Drill presses.	2 Bulldozers.
8 Bolt cutters.	5 Bolt headers.
7 Steam hammers.	4 Shears.
4 Trip hammers.	4 Punches.
4 Mechanical blacksmiths.	

Freight Car Shops

There are two freight car shops occupying the two northerly buildings of the car department group. One is 120 ft. wide by 374 ft. long and forms one wing of the building occupied by the woodworking mill. Six tracks run full length of this building, four of them being for car work and the other two for hand trucks carrying material and supplies. This building is in two sections, one of which contains a large overhead traveling crane.



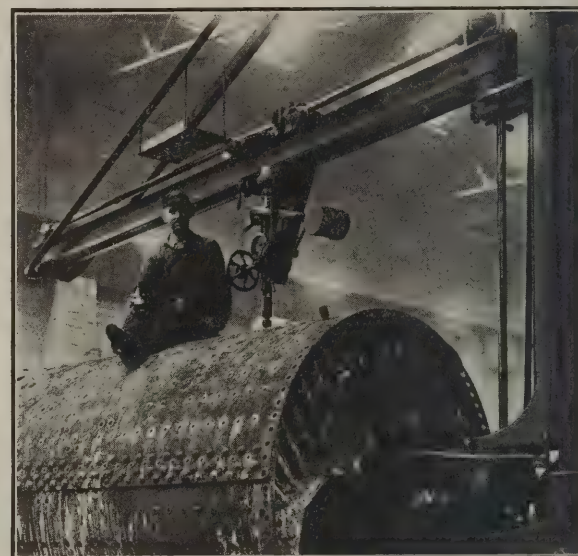
Motor Driven Angle Iron Shear.

The other car repair shop occupies a building 100 ft. wide by 502 ft. long containing four tracks. Both of these buildings are well supplied with windows and skylights and whitewashed inside. A total of 48 Cooper-Hewitt mercury vapor lamps have been installed in addition to nearly 100 incandescent lamps and the resulting illumination is highly satisfactory. One motor-driven line shaft and several motors are installed to drive the small amount of machinery required in these shops.

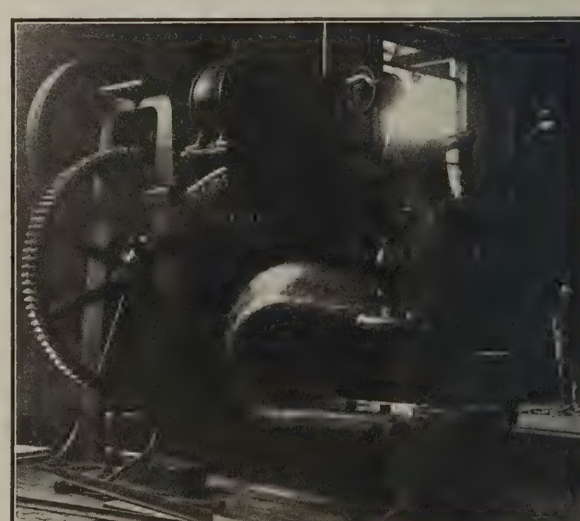
Passenger Car and Paint Shops.

The two largest buildings of the car department group are used for passenger car work. A transfer 80 ft. wide by 526 ft. long lies between and serves them both. The passenger car repair shop is 160 ft. wide by 362 ft. long and is in the building with the wheel shop. The latter is 100 ft. by 160 ft. A large skylight extends along the center with small ones each side, and steel lockers are provided for the workmen. There are eighteen tracks in this building and two cars can be placed on each track. The machinery in the wheel shop is group-driven from a motor-driven line shaft.

The passenger car painting shop, paint mixing room, varnishing room, upholstering room and cleaning rooms are in the other building. This is the easterly one of the north group and is 160 ft. wide by 462 ft. long, of which the painting room is 362 ft. long by 160 ft. wide. Cement floors are laid in this building and 16 tracks enter it from the transfer table. Each track will hold two coaches. Large skylights are provided, and large numbers of incandescent lamps are used for local lighting with arc lamps for general illumination.



Radial Drill in Boiler Shop.



Motor Driven Punch.

TABLE II—BOILER SHOP TOOLS.

3 Drill presses.	6 Shears.
3 Drills.	2 Bolt cutters.
3 Bending rolls.	3 Punch and shears.
7 Miscellaneous small tools.	

Blacksmith Shop.

The blacksmith shop lies in the center of the south group of buildings and is 100 ft. wide x 450 ft. long with an extension to the west 156 ft. by 110 ft. In the south end of the main building is the tin shop, which occupies a space 100 ft. by 100 ft. In the west end of the extension a space 60 ft. by 110 ft. is used as a bolt shop. All of the furnaces, bolt headers, threaders, etc., are located in here, and an overhead trolley crane serves the department.

A noticeable feature of the smith shop is the amount of space allowed for working and the general light, airy and clean appearance of the two rooms into which it is divided. The whole interior is whitewashed and well lighted and the floor is kept well sprinkled. Line shafting along the side drives all of the machine tools, and arc and incandescent lamps are used for lighting. There is no foundry at these shops.

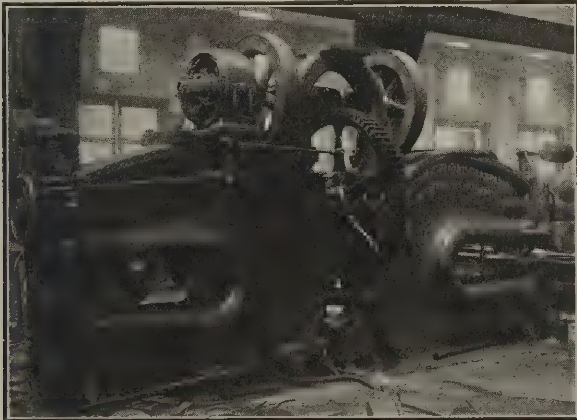
DISTRIBUTION OF POWER													
Departments	Lighting			Motors									
	Incandescent	Arc	Mercury Vapor	Machine No.	Machine HP.	Group No.	Group HP.	Crane No.	Crane HP.	Transfer No.	Transfer HP.	Turntable No.	Turntable HP.
Power Houses	53	7		3	175								
Loco. Machine Shop	467	14	4	3	7			10	190	1	15		
Freight Car Shops	93		48	5	86	1	25						
Pass. Car Shops	476	14		2	4	6	188					1	20
Blacksmith Shop	36	8		2	27								
Planing Mill	144			2	20								
Boiler Shop	72	36		10	144	2	100	8	153	1	50		
Round Houses	146			1	25							1	10
Store Houses	344	8						3	13				
Yards & Grounds	4	95											
Small Buildings	39	9		3	39	1	75						
TOTAL	1875	191	52	31	527	10	388	21	356	2	65	2	30

TABLE IV—PASSENGER CAR AND TIN SHOP TOOLS.

2	Lathes.	2	Drill presses.
3	Buffers.	6	Punches.
9	Shears.	6	Folders.
24	Miscellaneous small tools.		

Planing Mill.

The woodworking mill occupies the south bay of the westerly building in the north group and is 160 ft. wide by 342 ft. long, of which 100 ft. of length is taken for the cab and cabinet shops. All of the machinery in the wood mill is group-driven from overhead line shafts. In the engine room adjacent to this building is the large steam engine which drives this shop, and from the main line shaft belts run to successive shafts along the mill room in both directions. This shop is also well lighted through skylights and well whitewashed, and lighted entirely with incandescent lamps when artificial light is required.



Combination Punch and Shear.

A noticeable feature of this shop is the careful study evidently given to the matter of safety. Around each moving shaft, pulley and belt on or near the floor is a housing to prevent contact therewith by the employees. Very complete provision for fire protection has also been made. Some of the new induction motors will be installed in this shop.

TABLE V—CARPENTER SHOP TOOLS.

8	Mortising machines.	5	Planers.
6	Boring machines.	7	Tenoners.
4	Wood workers.	2	Shapers.
2	Grinders.	4	Moulders.
6	Lathes.	2	Jointers.
1	Sticker.	1	Matcher.
6	36-inch saws.	4	18-inch saws.
2	32-inch saws.	6	Small saws.
1	52-inch fan.		

TABLE VI—CRANES AND HOISTS.

1	100-ton electric crane.	10	1½-ton post cranes.
1	60-ton electric crane.	1	35-ton tower crane.
3	10-ton electric cranes.	15	Small cranes.
1	7-ton electric jib crane.	14	Air hoists.
6	1½-ton jib cranes.	42	Chain block hoists.

Roundhouse and Stores.

The two roundhouses lie in the southeast corner of the grounds near the main line tracks and east of the locomotive shop. One contains 25 stalls; the other, 37 stalls. Both have electrically operated turntables and are provided with steel lockers for the employees.

The feeder cables for the electric lights are carried around the outside of the walls just under the eaves, and branches are tapped off for each stall. The wires are carried through boxes containing switches and then through the wall and along the timbers overhead. Three drop lights are placed in every space between stalls.

Several storehouses are located at convenient places about the grounds, the principal one being two stories high. This is 70 ft. wide by 300 ft. long and, together with an oil house 60 ft. wide by 150 ft. long, occupies the space between the north and south groups of buildings. This large storehouse is conveniently arranged, all material being classified and kept in racks and bins. The interior is whitewashed and the bins painted green.

Between the blacksmith shop and the boiler shop is another storehouse containing steel bar stock and

(Continued on advertising page 14).

Telephones in Railway Service

J. H. FINLEY

The telephone has been for the past 30 years one of the necessities of business, beginning, of course, in a small way and gradually working up to its present prominent position. A business house of any moment at the present day could get along better without a bank account than a telephone. From the very first, the business men of the country adopted the telephone, as they readily saw that it increased and facilitated business, reduced the cost of operation, saved time, and had numberless advantages over messenger and even the telegraph.

The railroads of the country, on the other hand, delayed the adoption of the telephone generally for various reasons; among these probably the most important was the very much cheapened telegraph service they enjoyed. This coupled with the fact that nearly all railroad men from the presidents down to the agent in the smallest and most isolated town were or had been at some time in their career a telegraph operator, and naturally they had a sort of reverential awe for the key and sounder and a more or less distant acquaintance with the telephone.

The operation of the telegraph and the telephone, while fundamentally the same, are in the details of their working very dissimilar. The telegraph is operated from a direct current, the main line circuit being broken at each impulse and the circuit in its normal position is closed, which is, of course, an enormous waste of energy. The telephone circuit is operated with very high frequency alternating or pulsating currents, the circuit normally open.

It is the same with the telephone and the telegraph as with the direct current dynamo and the alternator; the general rise and development of the direct current machines far exceeded the advance and improvements in the alternators, although the alternator was the most simple and natural thing to develop.

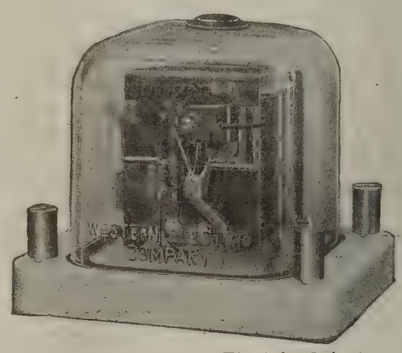
The use of the telephone was early advocated by some of the employees of the big railroads in the country for local and general business around the yards and stations, but the idea of using the telephone for train movements was long delayed and looked upon with disfavor by the operating officials of the country, some of them feeling that the information received directly by sound on the telephone would be less reliable than that translated from the natural tongue into dashes and dots and again from dots and dashes into the natural letters and words. Many of these same officials would be at a loss to explain why they thought as they did if suddenly called upon to do so.

The first roads to use the telephone in the movement of trains singularly enough were the smaller ones and some of the small branches of the larger roads. Just when this movement began in this way would be hard to even estimate, as we find new evidences of the early use of the telephone in this way every day.

The first notable example of the use of the telephone in place of the telegraph for putting out regular train orders on the main line of a large railway system from the dispatcher's office was probably on the New York Central Lines between Albany and Fonda, New York, although the C. B. & Q. Railway was so close a second that it is hard to tell which passed under the wire first and which deserves the credit of opening up to the railroad world this new and important improvement in operation. The work in the West, however, was very vigorously pushed, and under the guidance of one of the foremost pioneers of telephony on railroads was brought to a high state of development and given an impetus which nothing can stop, unless some new development superior in operation and more economical in practice is developed.

There have been many and varied steps in the intricate working out of the problems and difficulties encountered in the perfecting of the equipment. Then, too, the applications of the fundamental principles and the many advantages to be derived from the use of the telephone in conjunction with the telegraph, as well as the substitution of the telephone for the telegraph for various purposes, has developed a new field for telephone engineers, which is broader than would appear at first glance.

The telephone manufacturers of the country have



No. 50—A Western Electric Selector.

been compelled to learn many new ways of adapting equipment to meet the new demands of the special railway service. When railway telephone train dispatching began, the old time telephone engineer had to learn a new branch of the art. Whoever heard of a party line with fifty or sixty stations on it where one must be able to call any station at will and not call any other one at the same time, and where it is not only possible but desirable that as many as desire shall if possible listen when anyone is talking! For as all railway men agree, it is the proper thing for agents along the line to keep in touch with the location and condition of the trains.

These conditions had to be met, and thanks to the continued endeavor and the persistent efforts of the telegraph superintendents and the engineers of the various manufacturers of telephone apparatus, they have been met and the result is very gratifying.

The first condition of ringing individual stations was accomplished by various devices known as selectors, some of the original equipment is now obsolete—all of it is obsolescent.

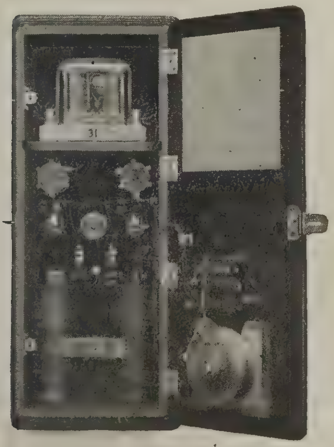
The original circuit installed on the New York Central lines employed a device known as the "Gill Selector" connected in series with the line. This form of equipment, while found to work fairly satisfactorily on short, lightly-loaded lines, was inadequate

to the requirements of a long, heavy-loaded line, and this arrangement rapidly gave place to the bridging circuit, long since found the only practical and economical way of operating telephone lines.

The original installation of the C., B. & Q. Railway was also the "Gill" series selector, but a new form of selector known as the "Wray-Cummings" selector replaced the original Gill equipment on this road.

It might be well here to mention that the telephone service on the railroads, as well as all well regulated and up-to-date equipped circuits for all telephone companies, require two wires instead of using the ground return as is the custom with the telegraph system. The principal reason for this requirement is because the telephone is much more sensitive than the telegraph to surrounding disturbances and to get away from this a pair of wires well transposed is required, especially when several telephone lines parallel one another, as like all alternating-current circuits, these lines are subject to inductive disturbances.

The talking circuit used on telephone train dispatching lines is of a special design, produced to overcome the objections to the local battery talking circuit when that was used in railroad service.



Way Station Selector Set

Foot Switch

With the standard local battery talking circuit, the bridged impedance is approximately 600 ohms, about half of which is active for receiving purposes. It is obvious, therefore, that when a number of these are bridged across the line simultaneously, the joint impedance of the parallel paths is very low and the transmission accordingly difficult between widely separated stations.

This is overcome in the present-day dispatching circuit by using a high impedance bridge, consisting of a 610-ohm receiver and 1 m. f. condenser in series across the line for receiving purposes. This gives the most efficient condition for receiving.

A switch is employed so that when an operator wishes to talk he throws this switch, thereby closing his local transmitter battery circuit and connecting the secondary of his induction coil to the line. Voice currents in the secondary have a path directly across the line in series with the condenser and also a shunt path through the retardation coil and receiver in series. This retardation coil is of about 6,000 ohms impedance and is placed in series with the receiver in order that the dispatcher may break in if it is necessary for him to interrupt an operator while talking. The impedance values are such that the amount of side tone is just sufficient for the operator to distinguish the dispatcher's voice if he interrupts, and he will then release his button in order to clearly understand what the dispatcher is saying. The outgoing transmission of this circuit is, therefore, the best possible consistent with the fact that the dispatcher must be able to interrupt an operator.

The art has now progressed to a high state of efficiency, a late development being the No. 50-A step-by-step selector, manufactured by the Western Electric Company. This selector and auxiliary apparatus is shown in Fig. 1.

The selector operates on the step by step principle, and when the proper number of impulses have been sent out over the telephone circuit the selector contact is closed and the bell rung. The dispatcher can hold this ring for any length of time he pleases by means of a key mounted on his desk. The bell is loud, and experience has shown it is in almost all cases answered promptly.

The keys which call these selectors are also interchangeable and can be adjusted to any numbered station desired. This feature is of great advantage in times of emergency. The operating mechanism of the selector itself is also so simple that it is maintained on roads using it at present by the regular maintenance man.

This is the very latest development in telephone train dispatching and it represents the care and skill which has been devoted to this branch of telephony by the country's foremost telephone engineers.

Telephone Train Dispatching on the Pennsylvania.

The general operation of a system of this kind may be described briefly as follows:

The dispatcher has a small cabinet located directly in front of him. This cabinet contains a number of small keys which operate individually, one key for each station cut in on the circuit. At the stations are located the selectors, the telephone and the bell. The operation of any key by the dispatchers operates all the selectors on the line, but only the one at the station set for the particular key operated closes the bell circuit and allows it to ring. When this bell rings a buzzing sound is sent back over the line, which tells the dispatchers that the bell is ringing. It, of course, is understood that any operator on the line may listen in at any time to what any other operator may be saying; this, however, on a train wire is an advantage rather than a disadvantage.

The wires usually employed for ordinary circuits up to 300 or 400 miles is No. 9 B. & S. copper; up to 70 or 80 miles No. 8 iron will give fairly good service; on short circuits good results could be obtained with a smaller size copper, but from a maintenance standpoint this would be impractical and since the circuits are continually being extended and the service to which they are put multiplied, it would not pay to economize on a single circuit to such an extent that extension would be impossible, as few of the

roads are now content to use a pair of wires for a single telephone circuit without multiplying this service by simplexing and phantoming for through telephone and telegraph circuit ofttimes over several divisions.

All portions of the equipment are suitably protected by high circuit and abnormal voltage protection.

Induction, as stated above, is overcome by transposition of the line wire, drainage coils and other special devices.

The advantages claimed for the telephone are numerous. Among them are increased speed. The speed is governed only by the ability of the dispatcher to write out the messages. The closer personal relation of the dispatcher to his men increases co-operation and efficiency. The answer back tells the dispatcher that the station has received the call. Anyone can answer this call in emergency. In emergencies, such as wrecks or washouts, anyone with the proper equipment can get in touch with the dispatcher and put him in direct touch with the situation.

No special training is required to handle the telephone, hence better men in general can be procured.

To summarize, the advantages claimed for the telephone over the telegraph are as follows:

Service:
- More rapid service in regular work.
- Better discipline.
- Closer co-operation.
- Greater flexibility.
- Immediate and accurate information in emergency.
- Closer supervision.

Economy:
- Dispatchers are relieved from mental and physical strain and can do better work.
- Some way stations may be closed entirely, the train crews taking messages direct.
- Larger field from which to draw operators.
- Employment for injured employees.
- More rapid handling of trains results in saving which cannot be computed, but is readily recognized by railroad men.
- Time is saved in case of delays due to wrecks or emergency troubles, such as washouts, split frogs, broken rails, etc.

Yard Charging Plants

By JNO. L. OHMANS

On roads using the straight storage or axle generator system of electric car lighting some provision must be made for charging the storage batteries on the cars at terminal points. With the first system this charging plant is all important, while with the second it is necessary to keep the batteries in good condition.

A discussion regarding the layout of a car lighting charging plant resolves itself into three parts:

First: The yard wiring for charging circuits. Four systems of wiring are commonly used, namely: (1) two wire mains with branches tapped off for each yard receptacle, each battery being charged at an approximately constant impressed voltage. (2) Individual positive leads to each yard receptacle with negative leads tapped on to a common return cable, permitting individual circuit control. (3) Individual two-wire circuit to each yard receptacle permitting complete control of each charging line. (4) Series charging circuits connection from four to eight yard receptacles in series, depending on the supply voltage and the voltage of the cars charged. This also permits complete control of the charging current.

Second: The charging station equipment for supplying current to the charging circuits. Two general systems are used; one furnishing an approximately constant potential to all charging circuits, the other furnishing a variable potential to each individual charging circuit.

Third: The supply of current. An ample supply of direct current must be available at these terminals. There are several ways in which this current may be secured: (1) It may be generated by a direct current dynamo driven by either a steam or gasoline engine or a steam turbine. (2) The dynamo may be driven by an alternating current motor, in which case we have a motor-generator set. (3) It may be rectified from alternating current by means of a mercury arc or other type of rectifier.

The last two methods presuppose the existence of a source of alternating current. This is true of practically all terminal points, the current being available from the lines of the city central station if not from the railway's own power house.

Unless the charging plant is located close to steam boilers supplying steam for other purposes, pumping for instance, the steam engine or turbine is not an economical source of power. For isolated plants the gasoline engine driven generator is well adapted. A 25-kilowatt direct-connected unit will take care of the battery charging required for five 60-volt or ten 30-volt cars per day, at a cost for fuel and oil of probably not more than 7c per kilowatt-hour. Of course, the efficiency of the set varies with the charging condition and is greatest when the full capacity of the dynamo is being utilized. For instance, if the dynamo has a full voltage of 250 at 100 amperes it will operate to best advantage when connected to two charging lines, each having three sets of batteries connected in series. The voltage impressed across the terminals of each set of batteries is about 75, allowing 25 volts for drop in the line. Each circuit carries 50 amperes.

Where alternating current is available it will generally be more economical to install a motor-generator set or a rectifier. The question then arises as to which of these is the more economical. For a given capacity the motor-generator is somewhat less expensive. The mercury arc rectifier has the advantage of more convenient unit size, it being more economical to operate 3 out of 10 rectifiers at full load than to operate a single motor generator at less than half load. This condition will obtain a large share of the time in any terminal charging station, while sufficient capacity must be provided to take care of emergencies.

The actual cost of a mercury arc rectifier capable of furnishing 325 volts at 40 amperes is about $350. This size rectifier can charge seven 30-volt or three 60-volt cars at one time. But since conditions are seldom

such that the full capacity of the rectifier can be utilized, it is not safe to figure on handling more than four 30-volt or two 60-volt cars per day with each rectifier.

The cost of maintenance of these rectifiers is very low. There are no moving parts and consequently no frictional wear. Breakage of the glass tubes, or their failure due to gradual exhaustion of the vacuum, is practically the only item of maintenance expense. The tubes have a guaranteed line of 400 hours. As a matter of fact the average life of four sets of 12 tubes each was 1,500 hours, while one set lasted over 4,000 hours. The tubes cost $28 apiece, less than two cents or each hour the rectifier is in use, or about one-seventh of a cent per kilowatt-hour. These figures were obtained on open glass tubes; for tubes immersed in oil even lower ones could probably be obtained.

A wiring diagram is shown of what may be considered an ideal charging plant installation. The scheme outlined gives a unit of installation which may be considered of minimum size for the proper development of the economies of the system; which consists of two charging lines eight hundred feet long, average length of an ordinary yard line, each equipped with ten-yard outlets spaced eighty feet apart; two mercury arc rectifier panels of forty amperes and three hundred and twenty-five volts capacity each, supplied from a transformer of twenty-five K. W. capacity; a distribution board equipped with Anderson plug receptacles and plug cables, permitting either one or two rectifiers to be connected in multiple to each line depending on whether more or less than forty amperes are needed for charging. The board is also equipped with a plug receptacle in series with each line permitting each to be connected in series with the other or the ampere hour meter inserted in the line at that point. The voltage impressed on the line is regulated from devices on the charging panel.

Absolute control of each charging circuit is a very desirable feature. If, therefore, only these kinds of circuits are considered it is seen that two wire circuits to each of twenty plug receptacles as shown in the diagram would involve 16,000 feet of wire and 8,000 feet of conduit, as against 3,200 feet of the same size wire and 1,600 feet of conduit for two series connected circuits of ten receptacles each as outlined. If, therefore, all other considerations are favorable the series connected charging lines are to be preferred considering first cost.

Mercury arc rectifiers as at present developed have a voltage range variable from 40 to 325 volts, which permits from one to seven batteries of 32 volts each to be charged on a line, leaving 30 volts to be absorbed in line losses if needed.

The cost of installing mercury arc rectifiers compared to a motor-generator set should be about equal. The efficiency of the former is over 90 per cent against a probably 75 per cent efficiency of a motor generator set. Against the cost of loss of power in rheostats in multiple circuits the cost of rectifier tube life may be balanced.

As regards the expense of installation of the auxiliary apparatus necessary to complete the charging system, these consist chiefly of the distribution board, transformers, meters and yard wiring. On account of the fact that cars cannot always be placed in the most advantageous position it will probably be necessary to allow one yard line 800 feet in length for every three cars to be charged, with a minimum of three lines. These lines should be laid in conduit and provided with outlet boxes every 80 feet.

The approximate costs of rectifier charging plants for handling various numbers of cars daily are shown in the accompanying table. In the plant layout one unit has been shown complete, extension being simply a matter of adding additional units.

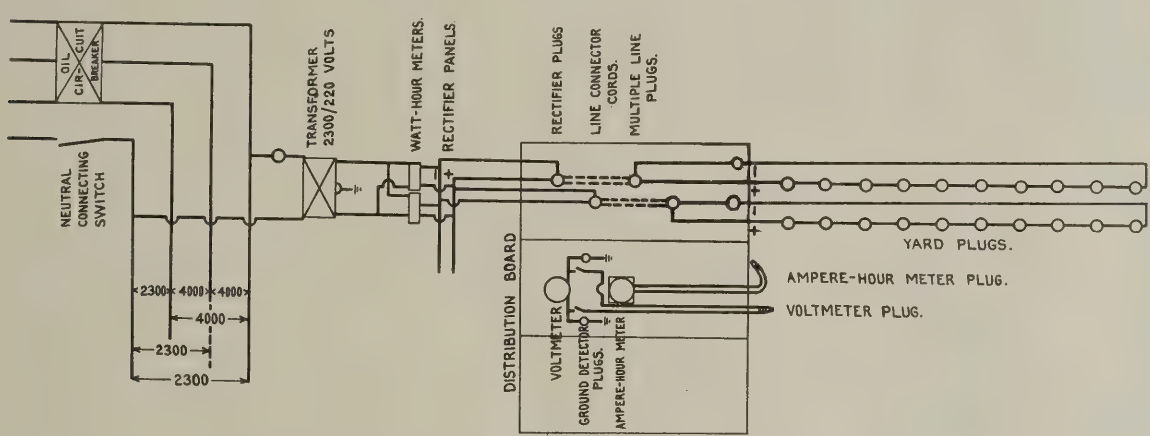


Diagram of Connections for Mercury Arc Rectifier Battery. Charging Plant.

APPROXIMATE COST OF MERCURY ARC RECTIFIER YARD CHARGING PLANTS.

For Charging Axle-Lighted Cars.

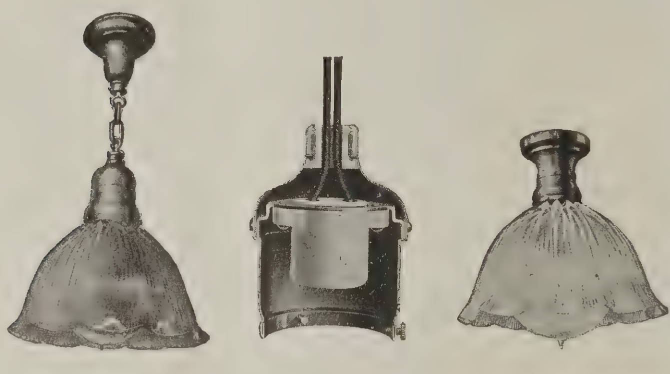
Item.	Number of Cars Charged Daily. 30 Volt.					60 Volt.				
	5	10	15	20	30	5	10	15	20	30
Rectifiers	$700	$1,400	$2,100	$2,800	$3,500	$1,400	$2,800	$3,500	$4,200	$6,300
Meters	200	200	200	300	400	200	300	300	300	400
Distribution Board	800	1,100	1,400	1,600	1,800	800	1,100	1,400	1,600	1,800
Yard Lines	1,800	2,400	3,000	4,200	6,000	1,800	2,400	3,000	4,200	6,000
Housing	500	500	1,000	1,000	1,000	500	1,000	1,000	1,000	1,000
Total	$4,000	$5,600	$7,700	$9,900	$12,700	$4,700	$7,600	$9,200	$11,300	$15,500
Per Car	800	560	513	495	423	940	760	613	565	517

The ABolite—A New Incandescent Lighting Fixture

Mr. W. C. Hine of Cleveland, Ohio, who for many years has been prominently identified with the developement and manufacture of lighting fixtures has recently developed and patented a line of Universal Holder Sockets. In a word, the holder socket is a simple unit taking the place of socket, shade holder and, at the same time, performing the function of a fixture for single unit illumination.

The Adams-Bagnall Electric Company, of Cleveland, has secured from Mr. Hine an exclusive license to manufacture and sell the line.

They have applied the principle to commercial and



1. 2. 3.

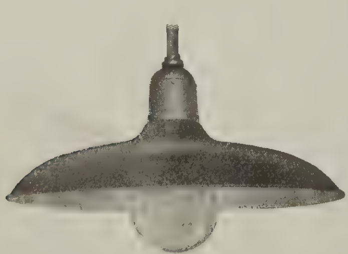
1.—3¼-Inch Pendant ABolite. 2.—Cross Section of 2¼-Inch Pendant ABolite Showing Positioning Device Thrown Downward to Give "O" Position. 3.—3¼-Inch Ceiling ABolite.

industrial lighting units and are manufacturing and selling them under the trade name "ABolites." A short outline of characteristic features will undoubtedly be of interest.

Commercial ABolites.

To obtain scientific illumination, it has always been necessary to obtain proper relation between lamp and reflecting surface. On account of different lengths of bases in Mazda Lamps, it has been necessary to attach several kinds of separable holders to a regulation Edison socket. The reflector in turn was suspended from the holder.

The primary construction characteristic of the ABo-



250 Watt 18-inch Dome ABolite.

60 Watt Bowl ABolite.

lite is the provision of a metal support for a reflector to replace variable holders.

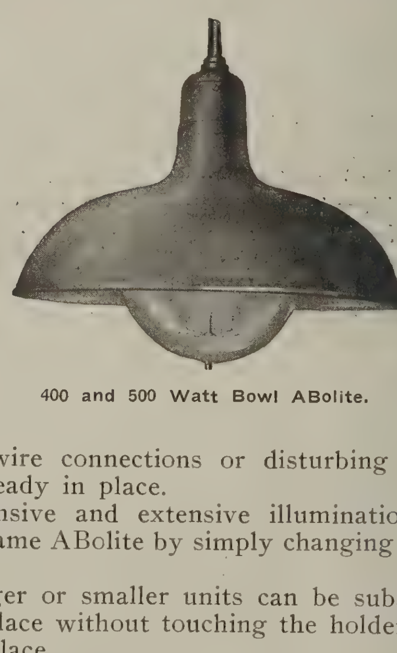
To this is applied the cardinal principle of a patented positioning device attached to a suitable porcelain receptacle. When the positioning yoke is thrown downward, the lamps and reflector are in the position obtained by use of "O" holders. When thrown upward, the "H" position is obtained. These two positions or intermediate ones are possible in ABolites designed for reflectors with 2¼″ fitters, that is for lamps 25 to 100 watt inclusive.

The same principle applies to reflectors with 3¼″ fitters, i. e. 150 to 500 watt inclusive. Two pendant (2¼″ and 3¼″) and two ceiling (2¼″ and 3¼″) ABolites take care of practically all single light illumination requirements on all lamps 25 watt to 500 watt inclusive. This obviates the necessity of carrying a large and diversified stock of lighting fixtures and accessories.

Industrial ABolites.

A complete Industrial ABolite is made up of two parts, the universal holder socket and the scientifically designed steel reflector. The following table outlines the salient features of the Industrial ABolite.

1. Positioning device provides for O, H and A positions.
2. Eliminates all separable holders.
3. One holder socket universal for all lamps, 25 watt to 500 watt inclusive.
4. All weight suspended from holder socket itself.
5. Reflector removed for cleaning without breaking any wire connections or disturbing the holder socket already in place.



400 and 500 Watt Bowl ABolite.

6. Intensive and extensive illumination obtained with the same ABolite by simply changing positioning device.
7. Larger or smaller units can be substituted for those in place without touching the holder socket already in place.

Efficiency Engineering.

In connection with this line, The Adams-Bagnall Electric Company has established a department of Efficiency Engineering for the purpose of studying industrial conditions and co-operating with industrial managers in bringing their illumination to a plane where labor efficiency and factory output will be greatly increased.

The work of this department is part of the general efficiency movement just launched, and it is believed that the initiative taken by this Company in the establishment of such a department will do much toward improving general industrial lighting conditions.

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

Education of Railway Electrical Employes.

ONE of the advantages of the head-end system of train lighting is that it involves comparatively few units of equipment, and these of a comparatively simple nature, and that, as a result, but little skilled attention is necessary. While this is true in the main, nevertheless some attention is required and this attention if not skilled must at least be intelligent. The lighting of the train is made as nearly automatic as possible, but it is always dependent upon the operator in the baggage car and in case of trouble its success or failure is absolutely up to him. Nine cases out of ten of actual failure are due to some minor difficulty which a little knowledge could easily have remedied.

It is important that the men in charge of these equipments should be instructed in the practical fundamental features of their operation and yet it is difficult to give this instruction. Undoubtedly the ideal method would be to gather them together in classes in a car equipped for actual service and show them the difficulties which may arise and how to overcome them. This, however, is an expense which the operating department would not, at present, countenance. To take its place one road has arranged to have each man who is to be in charge of a head-end equipment make at least one trip with a man who has had experience in this work. Supplementary to this a book of instructions is issued. In another place we have printed in full the contents of such an instruction book not so much for the information it contains as for the form and style in which it is gotten up. This book probably goes as far as any book can to make clear the operation of the equipment with which it deals. But no book can take the place of actual demonstration with the real thing.

Eventually the time will come when men in charge of lighting equipment will be instructed just as locomotive engineers and firemen are instructed today. And the sooner that day comes the better it will be for all concerned. It will be a big step toward better and more economical service.

November 6 to 10, 1911.

ACCORDING to all portents, signs and omens observed recently these will be large days for everybody connected with the electrical departments of the railways. They are the days on which the fourth annual convention of the Association of Railway Electrical Engineers will be held in Chicago. More interest is being manifested in this year's convention than in any previous meeting and at this writing, two months before the convention will open, preparations are further advanced than they have ever been so far ahead. The change in arrangements by which the meetings will be held in one room and the exhibits in another will be an improvement for both. It will also provide the additional exhibit space which seems likely to be needed.

The Association Committee Reports this year will no doubt be more comprehensive than any in the past. The papers to be presented will be more general in nature and will touch upon the problems of railway electrification and shop operation as well as car lighting. As usual all of these will be published in full in the November issue of the RAILWAY ELECTRICAL ENGINEER, which will be ready for distribution at the convention.

An Electric Railway's Shops.

A SLIGHT change in the order of the articles appearing in our Shop Series will be noted in this issue. The change has been made in order to include a description of the shops of the Chicago Railways Company, a typical electric railway, for comparison with the steam railway shops which make up the bulk of the series. There are, of course, certain radical differences between an electric railway shop and a steam railway shop on account of the difference in the rolling stock. But a great share of the work is the same in both and it is interesting to see how it is accomplished. The routing of work so that there is no lost motion in the process of manufacture is a feature of shop organization well worth attention, which is excellently illustrated in the shop described in this issue. The regular schedule of articles will be resumed in the October issue, this month's deviation meaning simply that one article has been added to the series.

CONVENTION ARRANGEMENTS.

Arrangements for the Fourth Annual Convention of the Association of Railway Electrical Engineers, which will be held at the La Salle Hotel, Chicago, Nov. 6-10 inclusive, are in the hands of the Railway Electric Supply Manufacturers Association. The officers of this association are: A. C. Moore, Safety Car Heating & Lighting Company, President; H. G. Thompson, Edison Storage Battery Co., and Geo. H. Porter, Western Electric Co., vice-presidents; J. Scribner, General Electric Co., Secretary and Edward Wray, Railway Electrical Engineer, Treasurer.

The following committees have been announced:

EXHIBITS: W. E. Ballantine, Chairman; H. W. Young and A. I. Totten.

ENTERTAINMENT: Geo. H. Porter, General Chairman.

Sub-Committees of Entertainment Committee.

BANQUET: Geo. R. Berger, chairman and Messrs. Schayer and Lew Kennedy.

SPEAKERS: Geo. H. Porter and W. L. Bliss.

DANCE: W. M. Lalor, Chairman, and Messrs. Kuhns, Hawley, Thompson, Moore and Schroeder.

THEATRE: W. F. Bauer, Chairman, and Messrs. Glatt and Bryan.

AUTOMOBILES: O. B. Duncan, Chairman, and Messrs. Newbold, Winchell and Cole.

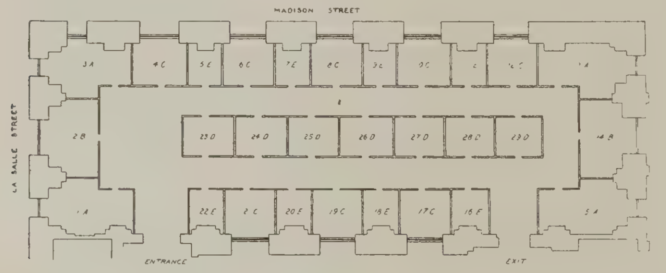
FINANCE: G. H. Atkin, Chairman.

MEMBERSHIP: J. Scribner, Chairman.

BADGES: J. M. Lorenz, Chairman.

AUDITING: R. M. Newbold.

PUBLICITY: Edward Wray.



The entire grand ball room will be used for manufacturers' exhibits this year. Twenty-nine spaces have been provided as shown on the accompanying plan. These spaces are designated in regard to size by suffixes, there being five different sizes as follows:

Suffix	Square Feet	Cost
A	182	$81.90
B	162	72.90
C	120	54.00
D	108	48.60
E	70	31.50

This is at the rate of 45 cents per square foot, and covers all expenses of decoration. In the matter of allotment of space it is simply first come first served so the sooner reservations are made the better.

Entertainment will include the usual opening reception and dance on Monday evening, banquet on Thursday evening, auto tour, theater party, etc. The name of Geo. H. Porter at the head of the entertainment committee is a guaranty of a good time for everybody.

HAVE YOU ANY APRIL OR AUGUST COPIES?

Our calls for back numbers of these months has been so great that our office supply is entirely exhausted. If you have a copy of each of these issues you are willing to part with kindly mail it to us and we will gladly extend your subscription four months.

CAR LIGHTING CLUB TO HOLD "GET TOGETHER" MEETING.

The first meeting of the season of the Car Lighting Club will be held Wednesday, September 20, at the Savage Club on the third floor of the Kuntz-Remmler restaurant at 424 South Wabash avenue, Chicago. A table d'hote dinner at one dollar a plate will be served at 6:15, the reading of papers and discussion to start about 7:30. Although there will be a regular paper for this meeting, it will also be a "Get Together" meeting at which plans for the season will be formulated.

A paper on "Axle Pulleys—Diameters and Speeds" will be presented by Geo. R. Shirk, chief electrician of the Chicago Great Western Railway. The paper will also include a discussion on the relative merits of belt and chain drives in axle lighting service.

The question box will be passed around and the last hour of the evening devoted to answering the questions which are forthcoming from the members.

ANNUAL CONVENTION OF I. E. S.

The annual convention of the Illuminating Engineering Society will be held in Chicago at the Congress Hotel on September 25, 26 and 27. Twenty different subjects in illuminating engineering will be covered in the committee reports and original papers to be presented. A reception and dance will be given on the evening of the 25th and a subscription dinner on the evening following. The papers to be presented are:

Presidential Address, The Relations of Physiological Research to Illuminating Engineering, by Dr. A. E. Kennelly.

Report of Committee on Nomenclature and Standards, by A. J. Humphries, Chairman.

Report of Committee on Progress, by Dr. Louis Bell, Chairman.

Symposium on Illuminating Glassware, by Bassett Jones, Jr., A. J. Marshall, L. W. Young, C. H. McCormack.

The Manufacture of Glass from the Viewpoint of the Illuminating Engineer, by E. H. Bostock.

An Analysis of the Requirements of Modern Reflector Design, by F. L. Godinez.

Recent Small Gas Lighting Units, by F. H. Gilpin.

Natural Gas, Its Production and Utilization, by G. S. Barrows.

Recent Developments in the Manufacture of Incandescent Lamps, by J. E. Randall.

The New Quartz Tube Mercury Arc Lamp, by Geo. C. Keech.

The Law of Conservation as Applied to Illumination Calculations, by Dr. A. S. McAllister.

The Photometry of Large Light Sources, by Geo. H. Stickney and S. L. E. Rose.

The Analysis of Performance and Cost Data of Illuminants, by Ward Harrison and G. H. Magdsick.

Photometry at Low Intensities, by Dr. Louis Bell.

Evaluation of Lamp Life, by P. S. Millar and L. J. Lewinson.

Distribution of Luminosity in Nature, by Dr. H. E. Ives and M. Luckiesh.

Resume of Legislative Enactments on Illumination, by E. L. Elliott.

Selling Illumination, by Frank B. Rae, Jr.

Influence of Surroundings and Lighting Systems on the Illumination Required, by J. R. Cravath.

Lighting of New Fast Trains of C. M. & St. P. Railway

Regular passenger service over the new coast line of the Chicago, Milwaukee & St. Paul Railway was opened on May 28 last. Two through trains are run each day between Chicago and Seattle, the trip requiring 72 hours. These two trains are called the "Olympia" and the "Columbia." To maintain them requires 18 complete trains, which are never less than 10 cars each, and frequently include additional sleepers.

The cars of these trains are of steel frame construction with wood lining. The normal train is made up of mail car, baggage-dynamo car, two coaches, tourist sleeper, dining car, compartment sleeper, two standard sleepers and an observation car.

The lighting of these trains is effected by a head-end system including a 20-kilowatt Curtis turbo-generator and three sets of storage batteries. Sixty-four volts has been chosen in preference to 110 volts on

The coaches are lighted by lamps placed along the deck rail under Holophane reflectors. Thirteen lamps are placed on each side opposite each other. The sleepers are equipped with combination gas and electric fixtures made by the Safety Car Heating & Lighting Company, porcelain hemispheres above the electric lamps serving as reflectors. The observation cars are equipped with Alba reflectors. An average illumination of 2.5 candle-feet on a plane 30 inches from the floor is maintained in the sleepers.

The electric lighting of these trains is handled by baggagemen in addition to their other duties. A total of 64 men are employed in this service on these trains none of whom have had any previous experience operating electrical equipment. For this reason it has been found necessary to issue the very specific instructions which will be found below. Excellent results have been attained in the past two months and there seems

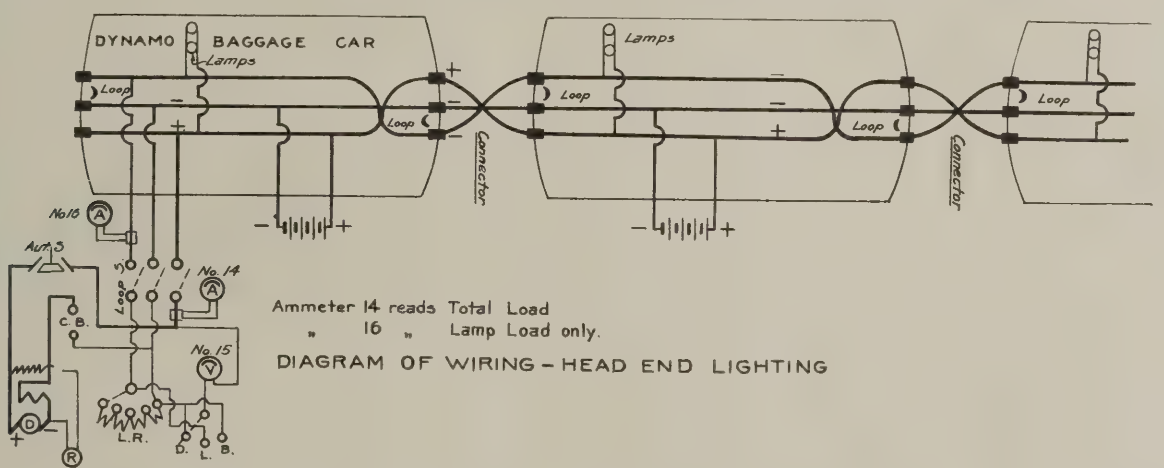


Fig. 1.—Wiring Diagram, C. M. & St. P. Head End Electric Train Lighting.

account of the saving in storage battery. The turbo-generator operates at 4,500 r.p.m. The storage batteries are the 13-plate, 32-cell type, with a capacity of 300 ampere-hours.

Tungsten and tantalum lamps are used throughout the train which contains 320 15-watt G-18½ tungsten lamps and 125 25-watt tantalums. The total connected lamp load is therefore 8,075 watts to which must be added the fan motors, portable vacuum cleaner, and several small toilet articles. The minimum lamp load, or load after midnight is 3,520 watts and the maximum load on the generator when all the batteries are charging is 11,440 watts. Eighty per cent of all battery charging is done on the trains. The division of the load throughout the train is as follows:

	No. Lamps.	Lamps Burning after Midnight.
Baggage Car	14	14
Mail Car	20	20
Two Coaches	56	30
Tourist Car	46	10
Dining Car	38	8
Three Sleepers	216	42
Observation Car	51	20
	445	144

no reason to suppose that this method of operation will not be entirely satisfactory, in addition to being very economical.

Figure 1 shows the electrical installation in the baggage car and gives a clear idea of the arrangement of the turbine and switchboard.

Figure 2 is a wiring diagram of the train and shows clearly the method of connecting the dynamo for carrying the lamp load only and for charging the storage batteries.

Figure 3 shows the trip report made out by the different baggagemen en route and forwarded to the office of the chief electrician. This report includes 9 blanks similar to the two shown, the last being filled out by the yard foreman at the terminal.

The following instructions are furnished in booklet form to all men engaged in operating dynamos on electric lighted trains:

Train Trip Report.

"In closet of your car you will find a train trip report. Fill out the portion assigned to your division, giving number of cars in the train and number of connectors received.

Under "Remarks" state any trouble you have with machinery or in lighting the train.

If an accident should occur to dynamo, turbine,

connectors, or lights, that you cannot repair, telegraph ahead to next station where such repairs can be made; also, if you should run out of supplies necessary to keep lights operating, telegraph ahead for them. Chicago, Milwaukee, Minneapolis, Miles City, Deer Lodge and Tacoma are repair and supply points.

Sign your portion of the report and leave it in car or hand it to the man relieving you at the end of your run. The report is to stay with the car until it reaches the terminal of the road, there it will be removed by Yard Electrician and replaced by a new one.

If your dynamo car should be set out of train enroute and another dynamo car put in its place take trip report with you, noting the change of cars on your portion of the report.

Operation of Dynamo and Lighting—(64 Volt Lamps).

See that the loop, switch No. 1 on switchboard, is closed, and that all other loops are open. See that all connectors are in place and thumbscrews tight. (Do not use a wrench or plyers on these thumbscrews.)

Switchboard—See that circuit-breaker No. 11 is closed. See that S. P. switch on auxiliary rheostat No. 7 is open. Place volt meter switch No. 10 on dynamo. See that switches 1, 2, 3, 5 and 6 are closed, and lamp resistance switch No. 4 rests on post No. 1. Be sure that automatic cutout No. 9 is open. This train is equipped with three storage batteries and automatic cutout No. 9 is on the board to protect dynamo from the current from the batteries. It must be open at all times when dynamo is not operating.

Look over dynamo and turbine and see that oil boxes and cup are full. The cup must be filled four times each night.

Ask the engineer for the amount of steam you require, 75 lbs., on the locomotive will be sufficient in summer and 100 lbs. in winter, even with a 12-car train. Blow the water out of separator, then start turbine slowly taking about three minutes to bring turbine up to speed. If drain pipe on steam separator should be stopped up, open the train heating valve and blow water into the heating system. As the turbine comes up to speed watch volt meter and work main rheostat No. 8 around until voltage reads about 66; then lift automatic cutout No. 9 by hand into contact and see that the voltage does not go higher than 66. Now put volt meter switch No. 10 on lamps and adjust voltage to 66. Do not carry lamps higher than 66 volts. Volt meter switch No. 10 must be kept on lamp circuit when lamps are being used. The other points on this switch are to be used only when you want to know the voltage of dynamo, batteries or ground. Should the turbine leak steam, loosen the set screw on stuffing box gland, screw up the gland a little and tighten the set screw.

If the automatic cutout No. 9 should heat at the points push the cross bar up hard. Better use a glove on your hand as points may be hot. There is no danger from the current in handling this apparatus with your bare hands.

If automatic cutout No. 9 will not stay in after you have been running an hour or so, throw lamp resistance switch No. 4 on point No. 2 and raise voltage to 66, that will raise the amperes on meter No. 14, and hold cutout switch No. 9 in place. Ammeter No. 16 shows the lamp load only.

If you should pick up a battery-lighted car enroute, during the night, before putting up the connectors, go to the car switchboard, open main switch and throw main lamp switch on batteries. If lamps burn dim, pull out lower main fuse; this will disconnect batteries, then throw lamp switch back on dynamo side and close main switch, put up connectors and light lamps from dynamo. If lamps burn bright from batteries you can put up connectors without removing main fuse. After daylight, when the lamps are all turned off and dynamo shut down, go back and put in the battery fuse. The other batteries will then charge into the low set and by the time you have to start the dynamo in the P. M. this set of batteries will work with the others in the usual way.

In case an emergency governor spring breaks and you have none to replace it take out both studs and

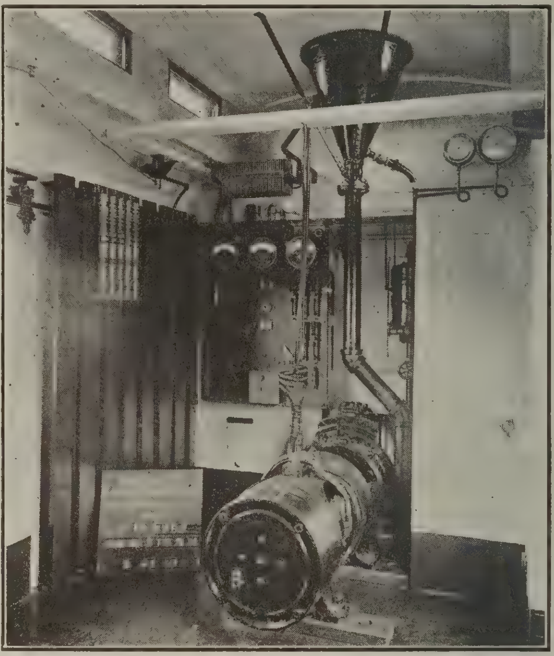


Fig. 2.—Twenty Kilowatt Turbo-Generator in Baggage Car.

run the turbine without them. Under these conditions you must throttle the turbine down so that it will just carry the load.

In case the turbine breaks down and cannot be repaired, notify the train conductor so that he may have the oil lamps in mail, baggage and passenger cars lighted, and the gas in the center lamps of sleeping and observation cars. Operate only the berth lamps and fans from the batteries.

To Test Main Fuses in Cars.

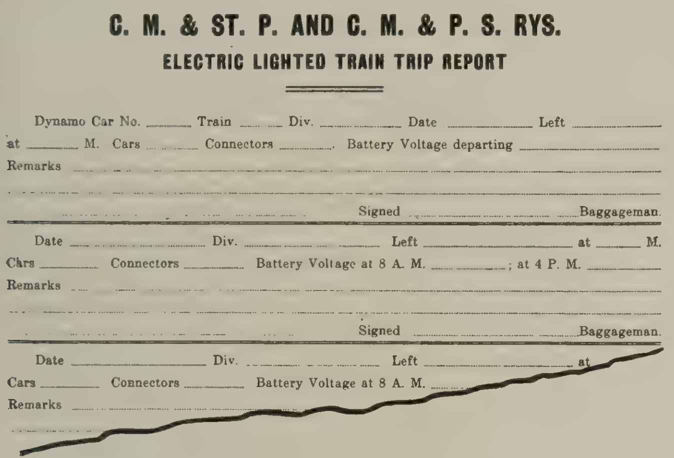
A test lamp socket will be in your car. See that you have a good lamp in it. Pull out main fuses at one end and put lamp socket across the two open ends, if the lamp lights up, the fuses are O. K.; if not put in new fuses and test them, continue this until you are sure fuses are all right.

Charging Storage Batteries on Trains.

At about midnight, or when the lampload has fallen to the minimum, begin charging. With everything running as it should, put volt meter switch No. 10 on lamps, and throw in No. 2 point of large lamp resistance No. 4. This will lower the voltage, then work main rheostat around until voltage is 66. If the dynamo voltage stands at about 75 to 78, let it alone; if not, throw lamp resistance to No. 3, and again raise lamp voltage to 66. Continue this until you have about 66 volts on lamps and 75 to 78 volts on dynamo. Amperes on ammeter No. 14 should now stand at about 180. Now let it run until ampere load has fallen to about five or six amperes for each battery, in addition to the lamp load. That is, if ammeter No.

16 should read 60 just before you begin charging, then, when the load on meter No. 14 gets down to 75 or 80, five or six amperes for each of the three batteries more than the lamp load, the batteries are charged and you can shut down the dynamo. Open circuit-breaker No. 11 and keep it open when dynamo is shut down. The batteries will now take care of the electrical load needed during the day.

Thirty minutes after shutting down dynamo, and



C. M. & ST. P. AND C. M. & P. S. RYS.

ELECTRIC LIGHTED TRAIN TRIP REPORT

Dynamo Car No. ______ Train ______ Div. ______ Date ______ Left ______
at ______ M. Cars ______ Connectors ______ Battery Voltage departing ______
Remarks ______

______ Signed ______ Baggageman.

Date ______ Div. ______ Left ______ at ______ M.
Cars ______ Connectors ______ Battery Voltage at 8 A. M. ______; at 4 P. M. ______
Remarks ______

______ Signed ______ Baggageman.

Date ______ Div. ______ Left ______ at
Cars ______ Connectors ______ Battery Voltage at 8 A. M. ______
Remarks ______

Fig. 3.—Report Filled Out by Train Electrician-Baggageman.

while ammeter No. 16 shows that lamps are still in use, read the voltage of batteries on meter No. 15, and put it on trip report. Again just before starting dynamo in P. M. read meter and put it in place marked "Battery voltage." If batteries are properly charged they will read 64 volts with lamp load on. It is very important that they should be kept charged. Otherwise, if dynamo should break down the batteries would not carry the fans and berth lamps the rest of the trip. When batteries are fully charged they will light all the lamps in a ten-car train for three hours; one-half of the lamps six hours and one-quarter of the lamps for ten hours. Before dark each day you should take test lamp, go back in train and see that main fuses are O. K.

If you should notice that voltage on batteries gets down to about 57 by 3 P. M., better start the dynamo earlier than usual, say at 4 P. M., so as to relieve the batteries. This will insure their being in good shape to carry the lights should an accident happen to turbine during the night.

While running the dynamo, should you come to a hill where the locomotive requires all the steam it can make, shut down the dynamo and operate the lamps from the batteries until the train is over the hill, then start the dynamo again. Consult with the conductor regarding the matter, as he will know when it is necessary.

Handling Connectors.

If cars are to be taken out or put in the train at a station, before reaching that station disconnect the connectors at both ends. Do not leave them hanging by one end in the vestibule; anyone coming in contact with the swinging connector may be burned from contact with it.

If a car or cars are set out of your train at any point, **connectors must be kept with the train, and not left with the cars cut out of train.**

Motor Drives for Railway Turn Tables

Economy of time and of operating cost are the most important considerations in the operation of railway turn tables. The relative importance of these two features depends on the amount of traffic to be handled. At a very busy yard the saving of time becomes the first consideration, and any device that will lessen the time required to handle engines and cars is welcomed. The greatly increased amount of traffic that can be handled in a given time is of more importance than the saving in operating expense. At the same time the careful and efficient management of modern railway systems demands that no unnecessary expense be incurred either in the first cost of apparatus or in its operating expense.

The increasing frequency with which turntables are used, as well as the increased weight of rolling stock in many cases, have compelled many roads to install power drive. Engines operated by air, steam, gas or gasoline have been used for this purpose and have resulted in a saving both of time and operating expenses. However, the constantly increasing use of electricity in railroad service is causing these devices to be replaced by electric motors, since an available source of power is often at hand without the installation of additional generating equipment. The motor consumes no fuel while idle, it is always ready for instant service, and it is under perfect control in the hands of a single and comparatively unskilled operator.

Simply closing a switch and moving a controller handle starts the table, and an efficient brake enables accurate stops to be made. The motors are designed and built to develop the high torque necessary for rapid acceleration; under average conditions the heaviest locomotive can be turned completely around in two minutes, and the table stopped accurately at the right point. The motor equipment can be installed in the small space which could not be economically utilized for any other purpose.

Power is available at almost every important railway yard or terminal, and the expense of installing and maintaining electric conductors is very small compared with similar expense for steam or compressed air pipes. Moreover, the losses by radiation and leakage in steam and air pipes are considerable and continuous. There are no corresponding losses for electrically driven tables, and the efficiency of electric equipment is much higher than steam, air, or gas engine drive.

Safety devices can be installed to insure full protection from injury in case of accident or careless operation. By the use of electric tractors, delays in handling locomotives can be avoided and schedules can be more easily maintained. The work is of an intermittent character and usually is rushing for a short period and then at a standstill. Especially is this true of turn tables at terminals, where many locomotives often come in at about the same hour. The much shorter time required by the electrical equipment to turn the table expedites the movement of the locomotive and relieves the congestion.

Economy of Electrical Operation.

Approximately average operating conditions are shown in the following account which applies to a railway turn table where a Westinghouse electric tractor superseded

hand operation. The value of time saving, although possibly more important than reduced cost, is neglected in the following consideration. The total cost of the electrical equipment, including installation, was approximately $1,500.

Annual Expense of Hand Operation:		
Two men 24 hr. per day, at 15c per hour		$2,628.00
Annual Expense of Motor Operation:		
One man 24 hr. per day, at 15c per hour	$1,314.00	
Current, average $8.00 per month	96.00	1,410.00
Annual Reduction effected by the use of Electricity		$1,218.00

If to the operating expense be added a charge of 12 per cent of the cost of the electric installation, or $180 for interest and depreciation, the balance in favor of motor operation is still $1,038. In addition, the saving of time and the increased amount of traffic that can be handled in a given period, while difficult to reduce to actual figures, will be of greater importance in a crowded round house than the saving in operating expense. The excellent showing made by the foregoing equipment resulted in the immediate installation of five more tractors of a similar nature and the determination to supersede all hand operated tables by electric tractors at important points on the line operated by this particular company.

Motor-Driven Turntable with Overhead Collectors.

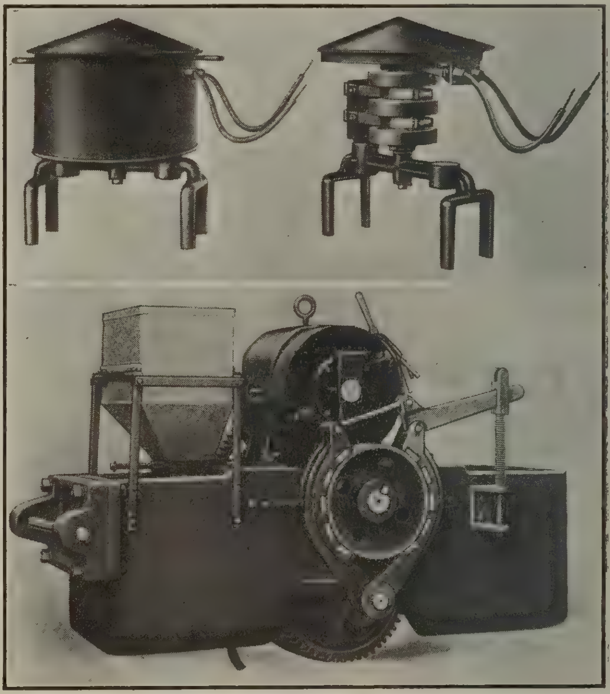
Construction of Tractor.

The motor is ordinarily applied to a heavy rectangular cast iron frame. A single, steel-tired, double-flanged driving wheel mounted in the tractor frame runs on the same rail as the turn table truck. Connection between motor and traction wheel is effected by means of double-reduction gearing. The tractor is preferably attached to the table by a hinge joint which allows some flexibility of connection and minimizes the jar to the tractor when the engine runs on or off the table. In some installations the motor has been mounted directly on the table, but this arrangement is not so satisfactory on account of the jolting to which the motor is subjected.

Occasionally a separate rail is installed on which the tractor can operate, the object being to insure a lower rolling friction for the table. In starting it frequently becomes necessary to use sand under the tractor wheel and it is evident that when both tractor wheel and turn table run on the same rail, the rolling friction of the latter is greater than it would be with the rail clean. However, this additional refinement is not usually considered essential.

The tractor is in effect a single wheel locomotive and consequently must be equipped with a motor suitable for frequent starting and capable of withstanding large momentary overloads. Where direct current is available, these conditions are well met by the series wound motor. In the case of alternating-current installations, polyphase slip ring induction motors are best adapted to this work. Experience has shown that anything less than 15 h. p. is not to be recommended as a general rule, although there are some installations where smaller machines are apparently giving satisfactory service.

The size of the motor is, of course, dependent upon the weight and rolling friction of the table with load, the diameter of track, and the time in which it is desired to make one complete revolution. It is usually possible to obtain prints of dimension drawings of the turn table and weight of the heaviest locomotive to be turned. From these can be calculated the pull which the tractor must exert in order to operate the table under the worst possible conditions, namely with the engine and tender unbalanced. The maximum draw-bar pull considered in connection with the speed, determine the capacity of motor to be selected.



Upper—Overhead Current Collectors.
Lower—Motor-Driven Turntable Tractor.

Equipment.

The turn table equipment consists of a complete tractor, including frame, motor, brake, and sander, also a controller, register, fuses and current collector. The controller and fuses, together with levers for operating the brake, sander, and looking device are contained in a cab located in the center of the table.

The controller is of a design which provides for operating at several different speeds forward and reverse and is arranged to obtain very slow speed just before stopping, in order to facilitate lining up the track. To further assist in this, a hand-operated shoe-brake is provided, the wheel being mounted on the end of the counter-shaft outside the tractor frame. Powerful leverage is thus provided and the heavily loaded table can be stopped within a short space and with the required accuracy.

For supplying power to the motor, the conductors may be brought through the turn table center-pin and connected to slip-rings from which the current is transmitted through brushes to the motor leads.

The collector consists of rotating and stationary parts and is mounted on a framework erected at the center of the table. The rotating part is bolted to the framework and revolves with the table; guy wires prevent the rotation of the stationary part.

Two important points to be considered in the location of the cab are the convenience and the comfort of the operator. It should be so situated that the jolts to which he is subjected will be reduced to a minimum and yet be near enough to the radiating tracks to enable him to make accurate alignment promptly. This is especially true where a large number of engines are to be turned, as otherwise time will be lost in lining up the tracks, thus defeating to a certain extent the purpose for which electric drive was installed.

Briefly stated, the advantages resulting from the use of electric tractors are: Great saving of time with consequent promptness of service; low cost of installation, operation and maintenance; ease of power transmission; absence of all energy loss while motors are idle; simplicity and accuracy of control; and reliability and high efficiency of operation.

ELECTRIC TRUCKS FOR FREIGHT AND BAGGAGE HANDLING.

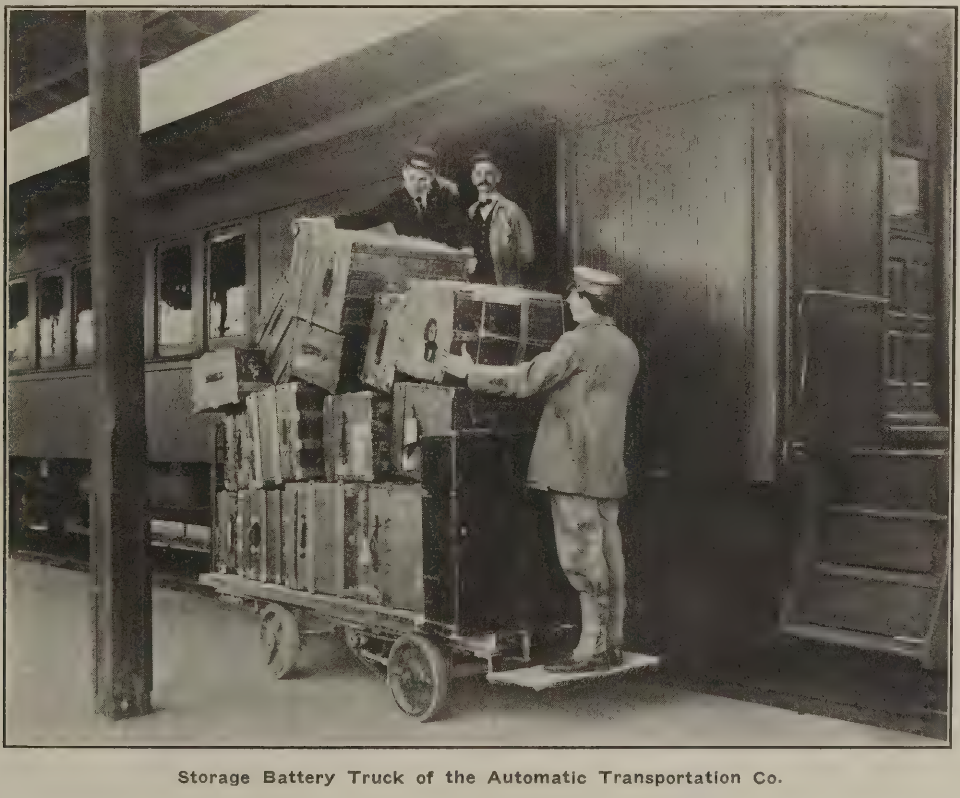
In the cost of operation of freight service, that of freight handling at terminals is a considerable item. The substitution of electric trucking for hand trucking has shown the way to reduce this item. On Pier No. 6 of the Erie Railroad at Jersey City the cost of handling freight with electric trucks in June, 1911, was 28 cents per ton as compared with a cost of 38 cents per ton for hand trucking in June, 1910. The total number of men employed was reduced from 126 to 80, but the average amount paid each man rose from $47.46 to $50.10, while the freight handled per man employed increased from 125 tons to 180 tons.

These results were achieved by the use of electric trucks similar to that shown in the illustration, which are equally well adapted to freight or baggage handling. The dimensions of the floors of these trucks are 42 inches wide by 10 feet 2 inches in length. The frame is supported on four spiral steel springs which transfer the weight of the load directly to drop-forged steel axles. These axles run in roller bearings which are mounted in solid ribbed cast steel wheel centers, around which are secured solid rubber tires, giving a wheel 16 inches in diameter. Steering is done by a lever which moves in a vertical plane.

Power for operating the truck is derived from a storage battery of two sets of 12 cells each with a capacity of 120 ampere-hours. Current is taken from the batteries through a fuse and circuit breaker, and a drum type controller, which is operated by a lever moving in a vertical plane through an arc of 120 degrees to give five speeds in each direction. No power can reach the motor unless the foot pedal has been pressed down. This motion simultaneously releases the brake and throws in the circuit breaker. The 2½ h. p. motor is connected to a sprocket on the jack shaft by a Morse silent chain. Chain drive also connects the jack shaft with the driving axles, giving a gear ratio with the driving wheels of about 5 to 1, which permits of speeds from 2 to 12 miles per hour under a load of 2500 pounds. The truck can be operated continuously under maximum load for 12 hours on one charging of the battery.

The operator or "motorman" stands on a small platform at the rear of the truck. The sheet metal case which contains the battery is immediately in front of him, while the levers controlling the motor and steering gear are handy to reach.

A number of these trucks are also being used on the piers of the Pennsylvania Railroad at Jersey City, and they are being tried out at the Silvis Shops of the C., R. I. & P. Ry. They are manufactured by the Automatic Transportation Company, 2933 Main Street, Buffalo, N. Y.



Storage Battery Truck of the Automatic Transportation Co.

The Lighting of the Davenport Locomotive Works

Pictures, like actions, often speak louder than words. It is the aim of this article to portray the method of artificial illumination that has been adopted in the Davenport Locomotive Works, of Davenport, Iowa, and the portrayal will rest mainly on the accompanying series of pictures, reproduced from unretouched photographs remarkable for their well-attested fidelity to the real appearance of the views represented.

The first view (Fig. 1) was taken in the Erecting Department at night without the aid of any other illumination than that afforded by the lamps as seen. If the light sources were only painted out of the picture and if the window-panes were touched up so that the light appeared to be coming from outside, one might readily believe that the photograph had been taken in broad daylight, so well is the department illuminated.

The second view (Fig. 2) shows the same shop by daylight and reveals the lighting units in detail. These are shop clusters equipped with metal filament lamps, a type of equipment which has now become very familiar for this class of service. Each of the units contains four 250-watt series burning lamps, capped by a white porcelain-enameled steel reflector 24 inches in diamter. The clusters are suspended by shock absorbers from diagonal members of the roof trusses and have ample clearance with the traveling crane, from which they are conveniently reached whenever it is desired to clean them or to replace dead lamps.

Figure 3 shows an aisle of the immense machine shop of the Davenport Works, as seen at night by the light of the incandescent clusters. The shop is divided into three parts, of which the middle one, shown prominently in the illustration, is known as Section No. 2; Section No. 1 is seen at the right and Section No. 3 at the left. The lighting in the middle section of the machine shop is of the same general type as that above shown for the erecting department, except that smaller clusters, each containing four 100-watt lamps, are here used instead of the 1,000-watt size. The intensity of illumination is considerably augmented by light coming in slantwise from Sections No. 1 and No. 3, and this light also materially improves the diffusion and tends to break up shadows. Figure 3, reproduced from a night photograph, should be compared with Figure 4, a daylight "shot" taken from nearly the same position.

The last pair of views (Figs. 5 and 6) show Section No. 3 of the Machine Shop, where work demanding the greatest accuracy is done. On some of this machining measurements to a fraction of a thousandth of an inch are standard. Such refinement, of course, demands a much higher intensity of illumination than is necessary elsewhere. Fourteen clusters of the thousand-watt size are here installed but are suspended much lower and spaced much closer together than in the Erecting Department. The floor area in question is 8,100 square feet, so that the watts per square foot are 1.73. The lamps, which are bowl frosted, are hung fifteen feet above the floor. As Figure 5 shows, practically all of the light is reflected downward on to the work, the ceiling being left in comparative darkness. The intensity of the artificial illumination in Section No. 3 on a plane 30 inches above the floor when the units are kept reasonably clean is estimated at from a minimum of 8, to a maximum of about 12 foot-candles vertically under units—an illumination fully equal to that of many a brilliant store window. By comparison with the estimated illumination in Section No. 2 and Section No. 1, 2.75 foot-candles and 3.5 foot-candles respectively (both generous values) the high intensity of illumination in Section No. 3 may be better appreciated.

The photographer who took the series of photographs here reproduced gives the following data relative to the conditions under which they were taken.

	Stop.	Exposure.
Day Views.....	U. S. 32	About 5 sec.
Night Views...	U. S. 32	2 to 5 min.. (No flash used.)

The Davenport installation, which has been found highly satisfactory in every respect, was designed and superintended by Mr. George Loring of Indianapolis, Indiana, representing the Shelby Electric Company. Mr. Loring's successful experience as an illuminating engineer has specially fitted him to undertake the large and difficult task of properly illuminating this immense locomotive works, and in the results of his work may be seen one of the best examples of the incandescent lighting of a large manufacturing plant to be found in the United States.

WHEN ORDERING EQUIPMENT.

The Safety Car Heating and Lighting News inquires if you would expect your tailor to furnish you a well-fitting coat if you gave him only your chest measurement and follows the inquiry with these very pertinent suggestions for ordering axle lighting equipment:

Voltage—Should always be specified.

Controlling Apparatus—Always specify whether the lamp regulating board can be placed inside of the car or whether it must be placed under the car; also give size of locker space inside of car for accommodating controlling boards.

Switch Panel—State how many circuits desired.

Generator Suspension—In order to design a satisfactory method for suspending generator under car, blue-prints or drawings showing style of truck to which the generator is to be applied, also the arrangement of the brake rigging, together with a drawing, showing under frame of the car, are required. If these drawings are sent with your order for the equipment considerable time will be saved and prompt deliveries can be arranged for.

Pulleys—If any particular size is desired, same should be specified.

Batteries—Specify number of cells, type and capacity of batteries.

Lamp Fixtures—Always state whether you desire key or keyless sockets, and where fixtures are applied to the deck of the car send a drawing showing cross section of deck so that the fixtures can be made up to fit the deck curve properly. Finish desired should also be specified, and if possible a sample plate showing the finish on both smooth and ornamental surfaces should be sent.

Fig. 1.—Erecting Department—Night.

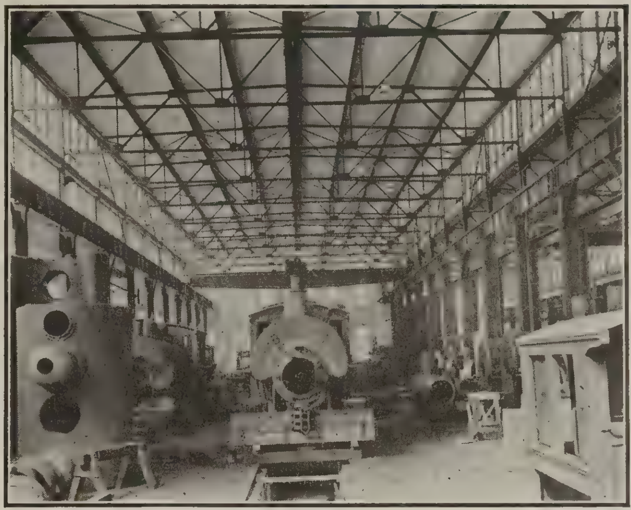


Fig. 2.—Erecting Department—Day.

Fig. 3.—Machine Shop, Section No. 2, Night. 300 by 40 ft. Area, 12,000 sq. ft. Lighted by 28 Mazda Lamps 28 ft. Above the Floor. Watts per sq ft., .934.

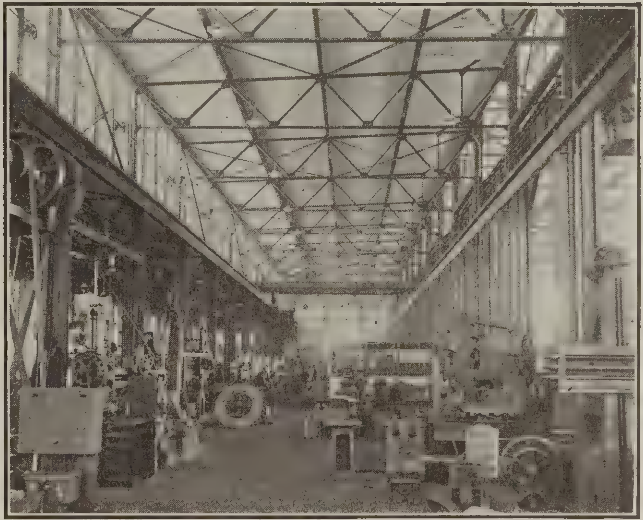


Fig. 4.—Machine Shop, Section No. 2, Day.

Fig. 5.—Machine Shop, Section No. 3, Night. 300 by 27 ft., Area 8,100 sq. ft. Lighted by 14 No. 5 Shelby Mazda Arc Lamps 15 ft. Above the Floor. Lamps are Bowl Frosted. Watts per sq. ft., 1.73.

Fig. 6.—Machine Shop, Section No. 3, Day.

THE LIGHTING OF THE DAVENPORT LOCOMOTIVE WORKS

The Design of Small Electric Locomotives

Small locomotives weighing from 25 to 35 tons each are quite extensively used in light freight switching such as is required in the yards of large industrial plants. After much study and experience it has been found possible to design a standard type which is well adapted to these conditions. The following description covers that designed by the General Electric Company.

The locomotive is designed for slow speeds and light loads with particular attention to simplicity of construction and accessibility of all parts. A typical locomotive of this type is shown in Figure 1—a 25-ton locomotive built for the Nashville Interurban Railway.

The platform framing consists of six pieces of channel and two large plates riveted together. Two 8 in. side channels and two 7 in. center channels, weighing 18.75 lb. and 14.75 lb. respectively, run the length of the platform. The end frame is an 8 in. channel. Two iron plates each covering half of the length of the platform, form the floor. A standard freight coupler with a 5 in. by 5 in. shank is carried in an extension of the drawhead casting, which is riveted to the center sills and end frame. M. C. B. standards are followed throughout.

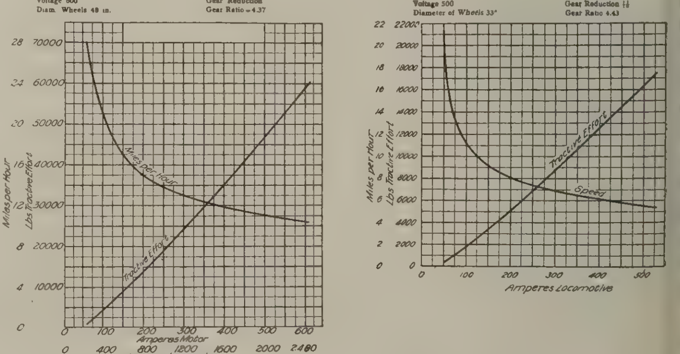
Thirty-five Ton Locomotive Built for Nashville Interurban Railway.

Arch bar trucks similar to those in most common use on freight cars are used, slight modifications having been found necessary to accommodate the motors and brake rigging. The brake levers develop a braking pressure of 85 per cent of the weight on the drivers, with 50 lb. air pressure in the cylinders. The brake cylinder is located midway between the trucks and attached to them by a series of levers so that the pressure of the brake shoes is always uniformly distributed over their surface.

The cab is built of sheet steel in three sections, the end sections being somewhat narrower than the floor and thus providing a running board. The center cab contains the controlling apparatus for electric motive power, air and sand and the switchboard and gauges. The end cabs provide housing for the controller resistances and an air compressor having a capacity of 25 cubic feet displacement per minute when operating against a 90 lb. reservoir pressure. An automatic governor maintains the air pressure at this figure.

The motor equipment consists of four 50 h. p. motors with cast gears having 71 teeth engaging in forged steel pinions with 16 teeth to give a gear ratio of 4.43 to 1. They can develop a tractive effort of 9,500 lbs. for one hour at a speed of 6.8 m. p. h. without excessive heating. The control circuits give six steps with the motors arranged two in series and four steps with them all in parallel. Continuous current at 500 volts is considered standard for this service.

Fig. 2 shows the interior of the cab. It will be noted that the end cab is easily accessible from the main cab should any repairs be necessary. The master controller is at the engineer's left hand, the air and sand controllers

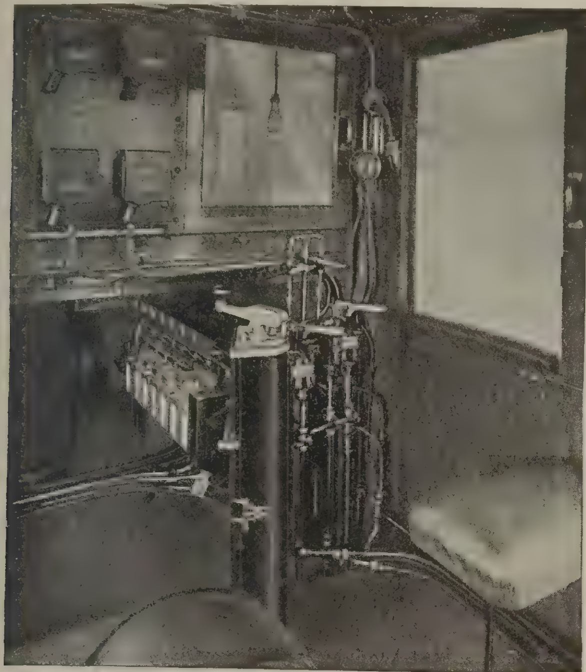


Characteristic Curves for 100 Ton and 25 Ton Locomotives.

directly in front of him. Windows on all sides permit unobstructed vision in any direction.

Fig. 2 shows characteristic curves for the 25 ton loco-

motive and for a similar locomotive, for heavier service, weighing 100 tons. The gear ratio for the two is practically the same but the larger locomotive is designed



Interior of Cab Showing Accessibility of Forward Cab.

to use 600 volt current, and has an entirely different framing. The tractive effort at the one hour rating for the larger locomotive is 36,000 pounds—18 per cent of its weight—while that for the smaller locomotive is 9,500 pounds—19 per cent of its weight.

The general specifications for the 25 ton type are as follows:

Length over all	26 ft. 0 in.
Height over cab	10 ft. 9 in.
Width over all	8 ft. 6 in.
Total wheel base	18 ft. 0 in.
Rigid wheel base	6 ft. 0 in.
Gauge of track	4 ft. 8½ in.
Weight electrical equipment	16,000 lb.
Weight mechanical equipment	34,000 lb.
Total weight	50,000 lb.
Body construction—All steel, channels, plates and angles	
Wheels	33 in. diameter rolled steel
Springs	24 in. full elliptic, 6 in. by ⅜ in. plates
Journals	4¼ in. by 8 in.
Motors	Four 50 h. p.
Gear ratio	4.43 to 1
Control steps	6 series parallel, 4 parallel
Maximum tractive effort	15,000 lb.
Tractive effort at one hour motor rating	9,500 lb.
Tractive effort at 3 hour motor rating	5,600 lb.
Air compressor	25 cu. ft. per minute
Coupler	M. C. B. 5 in. shank
Headlight	Luminous arc

SHOP SECTION
EDITED BY GEO. W. CRAVENS

Shop Series 5—Chicago Railways Company

Note: In response to various requests for informa-ion that would show the differences and similarities etween steam and electric railway shops, this des-ription of the Car Building and Repair Shops of the hicago Railways Co. is published at this time in our Shop Series." Later on we will describe one or more f the shops of roads using electric locomotives in rder to draw a closer parallel, and hope our readers ill find all these comparisons of interest and value.

The Chicago Railways Co. operates the surface ars running on the North and West Sides of the ity of Chicago, having nearly 2200 cars in regular peration. It has also about 200 "service" cars of arious types. The repair work on the entire equip-ent is done in the shops here described. The policy f this Company is to do as much of its own work as ossible; 300 old cars are now being rebuilt into the ew "pay-as-you-enter" type at the rate of 25 cars er month. Over 200 new semi-steel cars of the same pe with "turtle-back" roofs are also being built.

The Car Building and Repair Shops of the Chicago ailways Co. are located about one block west of arfield Park, in the west side of the city, and cover pproximately four blocks of ground. They extend om Lake St. on the north to Madison St. on the outh and are approximately 1600 ft. long by 325 ft. ide, being divided into four sections by the three itermediate streets. As indicated by the plan showing the general layout, there is a private alley containing a service track along the entire east side in addition to the various tracks connecting with those inside the buildings by means of the transfer tables.

Electricity is used throughout for power, over 600 H. P. in motors being installed, and with the exception of compressed air where indispensable, all auxiliaries are electrical also. Continuous current at 550 volts is used, taken from the operating lines of the company, and all changes in equipment required for installing individual motors were made in the company's own shops. This installation is unique in that it is one of the largest using automatic starters for the control of individual motor driven metal and wood working machinery, these being applied to adjustable speed as well as constant speed motors. All machines are equipped with push button control, for starting and stopping the motors, and all wiring is carried in iron conduits. The automatic starters are mounted in steel boxes near the machines. Reliance adjustable speed motors of the shifting armature type are used on all machines requiring speed changes.

Current is brought in to the main switchboard at the north end of the wood mill, from whence it goes through lead-covered cables in tile conduit underground to panel boxes in the various buildings, these boxes containing the circuit controlling equipments for the machine motors. All conduits are of galvan-

ized pipe with threaded fittings and junction boxes are provided for all branches.

Erecting Shop and Wood Mill.

These departments are in one building at the north end of the property, as are also the Cabinet, Fender and other smaller departments. This building is approximately 397 ft. long by 320 ft. wide, being some what irregular in shape, and is fireproof throughout. The walls are of brick on concrete foundations and the roofs and girders are of re-inforced concrete. Large areas of skylights are provided, these being of plain glass with wire net below. The supporting columns for the roof are of concrete, encased with steel to prevent mechanical injury. The building is one story high excepting along the east side where the smaller departments are located. This portion is two stories in height.

Two of the four sections of this building are occupied by the Erecting Shop, each of them containing 6 through tracks which connect with the transfer table at the north end and extend across the street at the south end to the next transfer. The capacity of this shop is 36 cars of standard type at one time.

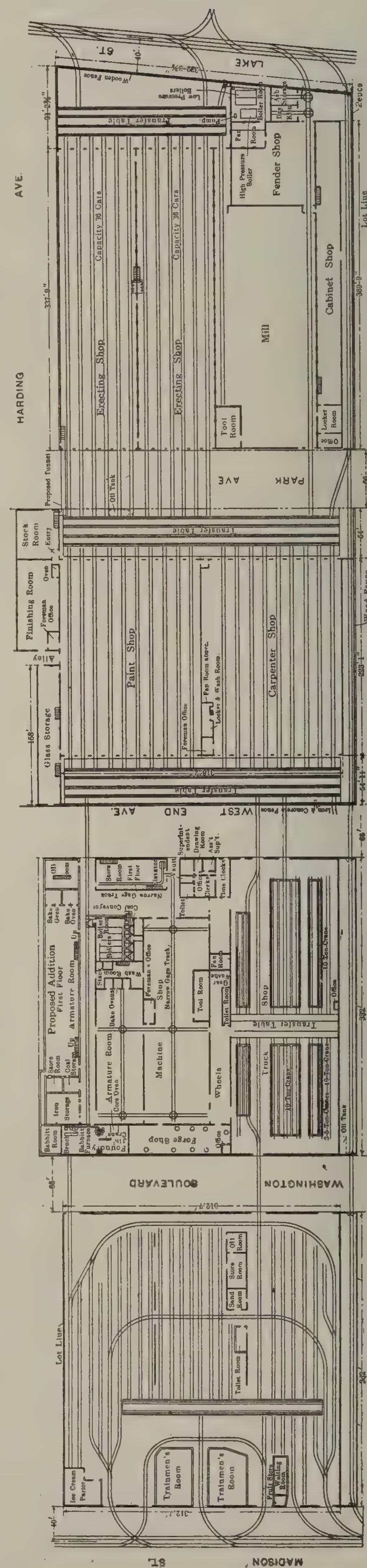
The wood mill occupies a section 265 ft. long by 112 ft. wide with a track running along each side. The machines are so grouped that four aisles run full length of the room, thus allowing ample space for haulage and material, and are arranged so that material passes from one to the other when processing through. Thirty-six trucks are provided for handling material in this department. Three exhaust pipes with separate motor driven fans carry out shavings and dust, there being an inlet at each machine. There is also an outlet from the compressed air system at each alternate column for blowing dust into exhaust when cleaning up.

Every machine in the wood mill has its own motor and automatic starter, there being 56 new tools installed. All of the customary machines required for such work are found here. The following list names them and gives the motor capacities.

WOOD MILL MACHINERY.

No.	Machine.	Motor H. P.	No.	Machine.	Motor H. P.
1	Tenoner and gainer	15	1	Band saw, tilting frame	8
3	Tenoners	5	2	Band saws, small	5
1	Double head tenoner	15	1	Double head saw	5
3	Shapers	5	1	Universal saw	10
1	Paneler	5	1	Self-feeding rip saw	6
1	48-in. 3 roll sander	20	1	Plain rip saw	6
1	Upright sander	2	1	Large rip saw	12
1	Small sander, hand feed	2	1	Large self-feed rip saw	8
1	Universal wood worker	7½	1	Cross-cut saw	6
1	Porter jointer	5	1	Automatic cross-cut saw	15
1	24-in. jointer	3½	1	26-in. re-saw	30
1	Sash and door rabbeter	7½	1	Cross-cut saw	7½
1	Dovetailer	3	1	Jig saw	2
1	Doweling machine	5	1	Square hole mortiser	15
1	Timber sizer	40	1	Hollow chisel mortiser	6
1	36-in. surface planer	15	1	Small mortiser	2
1	30-in. planer	10	1	Carver and molder	3½
1	Boring machine, small	3	1	Door molder and sticker	5
1	Gang boring machine	10	1	12-in. molder	15
1	Boring machine, medium	6	1	Combined ripper and molder	12
1	Twin saw, tilting table	5	1	9-in. molder	10

A tool room is located in one corner of the wood mill and contains grinders, saw-filers and a steam chest for use in preparing wood for bending. The

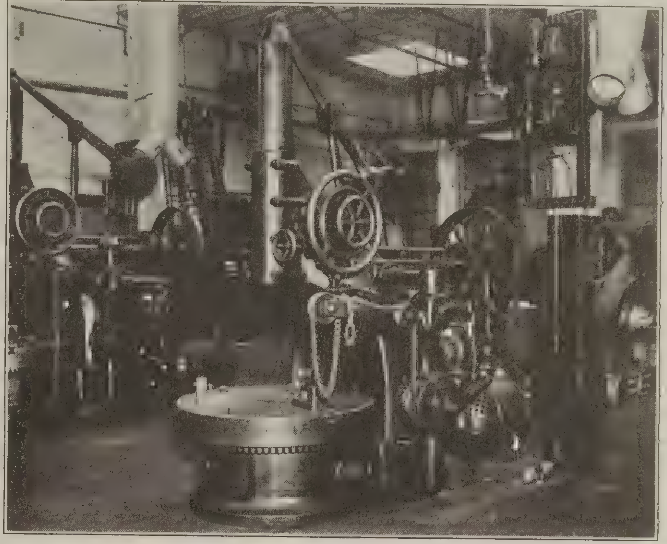


Layout of the Shops of the Chicago Railways Company.

lockers and tool cases are of steel, 40 in. high by 34 ft. 4 in. long.

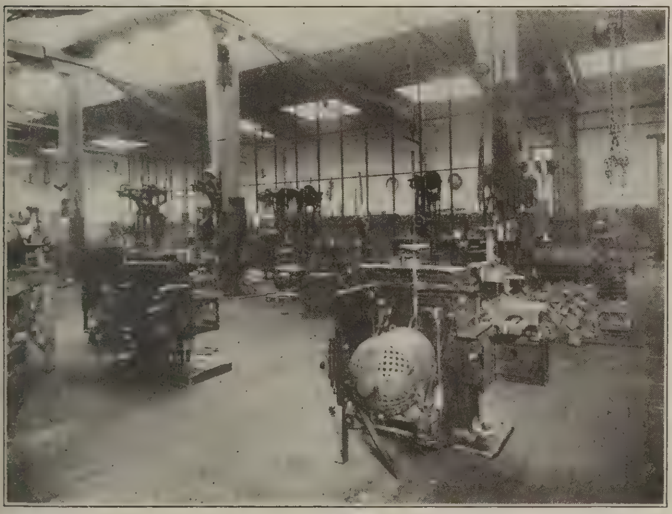
The two story annex to the wood mill is 28 ft. wide by 370 ft. long and contains the cabinet shop on the ground floor and the broom shop, tin shop, pattern shop and pattern storage on the second floor. The tin shop contains four work benches, one folder and two cutters, while the pattern shop contains a speed lathe, a planer and a board saw. All of these small shops are equipped with steel racks and shelves for storage.

General View of Chicago Railways Shops.

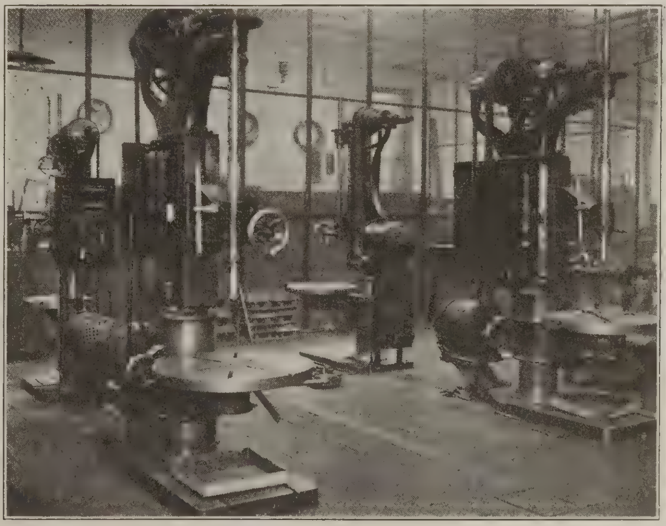


Car Wheel Borers Driven by 7½-H. P., 500-1,500 r. p. m. Motors with Automatic Starters.

The Fender Shop is approximately 100 ft. square and contains motor driven pipe cutters, threaders and reamers, two drill presses and an emery wheel, as well as work benches and assembling fixtures. The dry kiln is 16 ft. by 30 ft. and contains a single track connecting with the rest of the shop trackage.



Machine Shop. 20-inch Shaper Driven by 3½-H. P., 300-1,500 r. p. m. Motor with Push Button Control.



Upright Drills Driven by Adjustable Speed Motors with Push Button Control.

Carpenter and Paint Shops.

The second building from the north end contains these two departments and is 223 ft. long by 316 ft. wide with a dividing wall along the center. The construction of brick and concrete similar to the erecting shop, but a saw-tooth roof was used as being more suited to the purpose than plain skylights. The building is shorter than the block it occupies in order that a transfer could be built at each end. This allows the transfers to feed each side of the shop without requiring an opening through the fire wall between, and lowers the insurance rate as a result.

The Carpenter Shop contains nine through tracks with a continuous concrete pit running full length of each. The floor between is of concrete. The Paint Shop contains ten through tracks but no pits, the concrete floor being sloped to the drains which are 50 ft. apart. Adjoining the paint shop is an annex containing a finishing room, stock room, glass storage, sign and curtain rooms. Offices for the foremen are also provided at two places in this building.

Owing to the nature of the work done here, and to the fact that most parts come from the mill and machine shops finished and ready to assemble, the equipment of tools is small. In addition to six benches and a glue pot there are two grinders and a series of steel racks and boxes.

The paint shop annexes contain the small amount of machinery required. This consists of two motor driven sewing machines and an emery wheel and a special folding machine for canvas straps. These

straps, made of four thicknesses of canvas and double stitched, have been found better than leather for holding cables under cars. A baking oven 7 ft. by 15 ft. is installed in the finishing room for small parts which have been enamelled. The tanks containing naphtha and gasolene are each of 400 gal. capacity and are buried outside of the building under the concrete paving, pipes coming to gauges inside the stockroom to indicate the level of the contents of the tanks. The paint shop has a capacity of over 2,000 cars per year.

Machine and Truck Shops.

The building standing second from the south end is one of the older buildings and has brick walls and wood roof. Small skylights are placed at intervals along the roof and high windows are in the walls. This building is also in two main sections, one containing the machine shop and the other the truck shop, the entire building being approximately 300 ft. wide by 332 ft. long, and filling the block. Two tracks enter the truck shop from the north, one of which runs through and across to the service building to the south. A small transfer table runs across the truck shop near the center.

The machine shop proper occupies 72 ft. by 228 ft. of the west half of the building, and has recently been re-arranged and fitted out with several new machines and a large number of new motors. The machines and benches are now so arranged that work can be run through with great economy. A feature of this shop is a polishing bench upon which is mounted two grinders, two buffers and three small drill presses with a single driving motor underneath. An exhaust fan is also attached.

The large tool room is equipped with steel shelving, drawers and counters, and is 20 ft. by 70 ft. in size and caged in up to the roof. In addition to jigs and fixtures for many operations there are the following machines driven by motors:

1—Universal shaper	5 H.P. motor
1—Universal milling machine	2 H.P. motor
1—Four speed sensitive drill	1 H.P. motor
1—16-in. tool room lathe	5 H.P. motor
1—Universal grinder	1¼ H.P. motor
1—Yankee drill grinder	1 H.P. motor

Throughout the shop portable stands for tools and supplies are used, and a gear and casting cleaning tank is installed for removing grease with hot soda water. The following motor driven machine tools are installed in this shop.

MACHINE SHOP EQUIPMENT.

No. Machine.	Motor H. P.	No. Machine.	Motor H. P.
1—Combination punch and shear	15	1—Screw machine, 1-in.	2
4—Punch presses	5	1—Screw machine, 2¼-in.	3½
1—Cold saw, 24-in.	5	1—Broacher	3
1—Emery wheel	5	1—Double head planer	15
2—Twin emery wheels	5	2—Planers	5
3—Car wheel borers	7½	1—Automatic tapper	1
3—Hoists for wheel borers	1	1—6 spindle nut tapper.	3
2—Hack saws, combined	5	1—18-in. bearing lathe.	3½
1—Milling machine	10	2—21-in. turret lathes	5
2—Milling machines	5	2—Feed motors for lathes	1
2—Hand milling machines	2	1—Horizontal boring machine	5
1—18-in. shaper	5	7—Drill presses, various	1 to 3½
1—Keyseater	32	1—Radial drill, 2 ft.	3
1—42-in. lathe	15	1—Radial drill, 4 ft.	5
9—Lathes, 24-in.	5	1—Radial drill, 5 ft.	6
1—Axle lathe	7½	1—Multi-spindle drill	1
1—Axle lathe	10		
3—Bolt cutters	5		

The Truck and Wheel Shop occupies a space 332 ft. by about 125 ft. wide and contains nine tracks, five of which are over pits. There are five cranes in this shop, three of which serve the truck section and two for the wheels. There are two 10-ton Niles cranes, one Case crane with two five-ton hoists, one 10-ton Whiting crane and one five-ton General Pneumatic Tool Co. crane. All of the 10-ton cranes are cage-operated. This shop is also equipped with three oil rivet heaters on carriages, three air hammers, three air riveters and two 16-inch Ransom twin grinders, each with a 5 H. P. motor. Six testing stands for motors are provided, each with a complete equipment.

A feature of the wheel department is a large Wm. Sellers wheel lathe driven by a 35 H. P. Westinghouse motor, variable speed and direct connected. This lathe has two turret heads, with a separate motor for the tail stock. It is also equipped with a reversing controller and two snap switches. These switches are mounted near the operator and one is for half speed and the other for instant stopping.

This building also contains the Air Brake and the Electrical Departments. The air brake equipment includes a double bench fitted for service tests, with an independent compressor outfit beneath for valve and gauge testing. Governors may also be tested here. Stock is kept in bins at one side of this section.

A space about 50 ft. wide by 150 ft. long is used as an electrical shop and armature room. Yale & Towne overhead trolley hoists serve this room in conjunction with the two tracks from other rooms. All of the repair work for the 2,200 cars in service is done here, in addition to miscellaneous work. A circuit breaker testing stand is here, arranged so breakers may be tested in operating position. Two small portable electric ovens are used for heating and softening armature coils before assembling, each taking 2¾ amperes at 500 volts.

The principal machine tools in the electrical department are the hydraulic press, armature banding machine, commutator grooving machine with ½ H. P. motor, a milling machine with 2 H. P. motor, a 20-inch lathe with a 3½ H. P. motor.

Blacksmith Shop and Foundry.

These departments occupy a space 14 ft. wide by 190 ft. long across the south end of the machine and

DISTRIBUTION OF POWER

Department	Lighting			Motors					
	Incandescent	Arc Lamps	Mercury Vapor	Machine No.	Machine H.P.	Crane No.	Crane H.P.	Transfer No.	Transfer H.P.
Wood Mill	30	31		47	400				
Machine Shop	145	32		64	325	2	15		
Cabinet Shop	155		10						
Erecting Shop	630	72							
Carpenter Shop	800	60							
Paint Shop	930	70							
Truck Shop	50		40			15	95	1	75
Forge & Foundry	20	4							
Yards & Stores	200	39				1	7	3	225
Miscellaneous	350	7	10			2	15	1	75
TOTAL	3310	315	60	111	725	20	132	5	375

truck shop building, of which the forge shop comprises 60 per cent. This portion is equipped with eight skylights, each containing two 12-in. ventilators, and a ventilating system which supplies warm air in winter and cold air in summer through outlets near each forge. There are nine forges here, each fitted with a hood and a 16-in. ventilator.

The tools in this shop include two steam hammers, one 1,500 lb. and one 600 lb., a 600-lb. Bradley hammer, a No. 3 Acme forging machine, a No. 6 Ajax forging machine and four oil furnaces. About 1,000 gallons of crude oil are used here each week. Motor driven line shafts are installed to drive the machines, the motors being in the machine shop to avoid the dirt and heat.

Electric Steam Generators for Train Heating

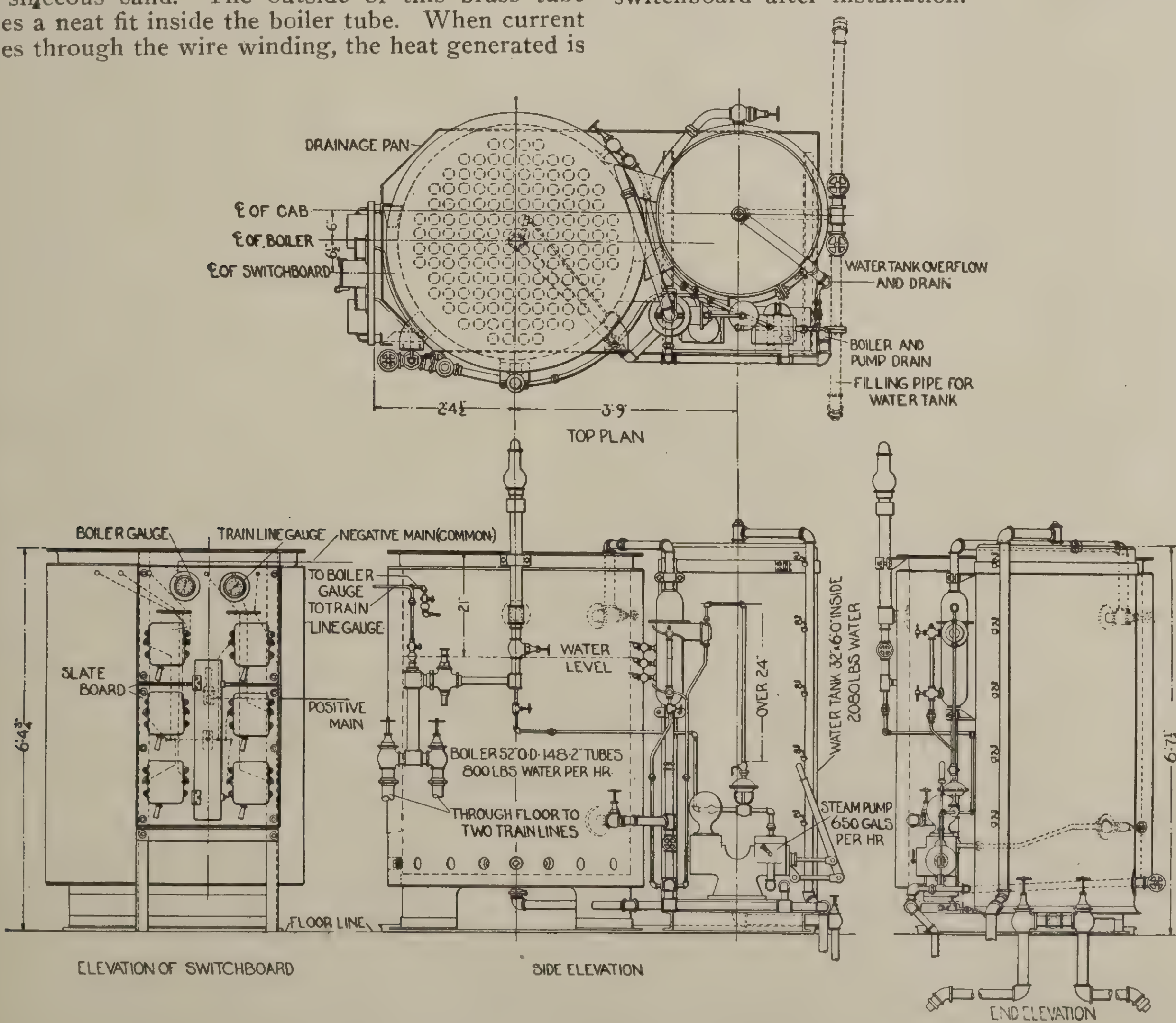
The electrification of railroad terminals has brought up the problem of heating trains while operating in the electric zone. As it is not practicable to install electric heaters in the car, some method of generating steam on the electric locomotive is necessary. The time consumed in getting steam through a cold trainpipe has to be seriously considered, even when the distance between the terminal and the transfer station is so short that the actual heating of the cars for the time the train is without steam is not an important factor. This consumes from three to five minutes, and must be reckoned from the time the steam locomotive is attached to the train.

The Safety Car Heating & Lighting Company has designed a steam generator in which heat to make steam is obtained from electric current taken from the third rail. The generator is a vertical tubular boiler, with heating elements placed within the tubes. Each unit consists of a core of insulating material on which is wound a wire of high heat resisting quality. The core with the wire is slipped inside a thin brass tube, the core being spaced away from the sides of the tube by porcelain insulators. The space between the core and the sides of the tube is completely filled with a fine siliceous sand. The outside of this brass tube makes a neat fit inside the boiler tube. When current passes through the wire winding, the heat generated is conducted through the sand and boiler tube to the water in the boiler. The sand acts as a means of conducting the heat from the wire to the boiler tube, and also acts as an insulator. As the heating element is not in contact with the water no electrolytic action is possible. Each unit is complete in itself and can be easily removed by disconnecting the electric connections, and slipping the complete unit out. The units are all connected in multiple, and each one is provided with a fuse, arranged to blow if the current rises to sixty per cent above normal.

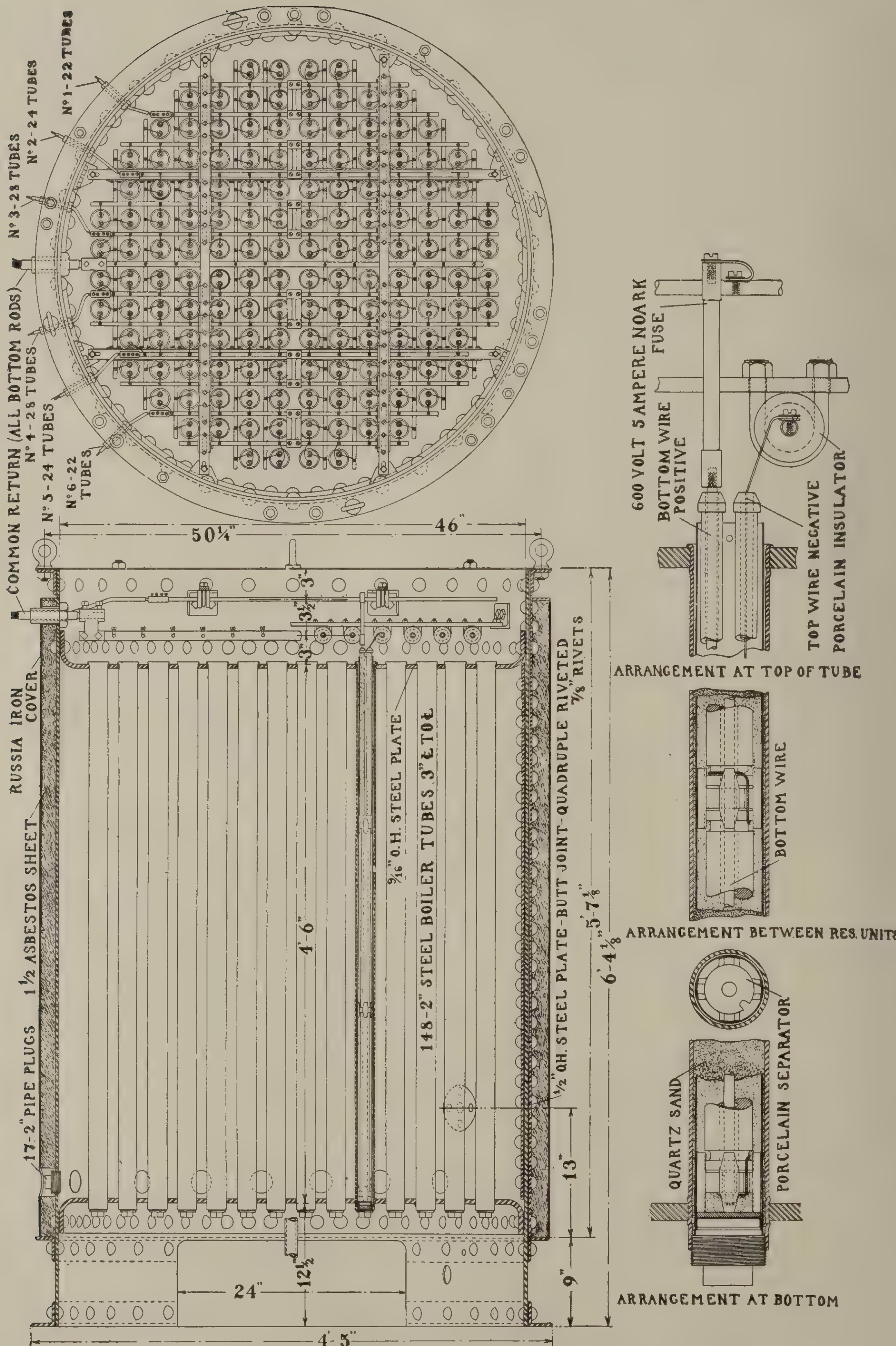
The connections from the units are made to bus bars at the top of the generator. The units are grouped in sections controlled by suitable switches, to control the amount of steam generated. No arrangement has been made for automatic control of the steam pressure as experience has shown that this is not necessary.

The feed water level is automatically maintained by a steam pump controlled by a float relay.

Fig. 1 is a general view of the generator, water tank, feed water heater, and switchboard as installed in the locomotive cab. Fig. 2 illustrates a section of the boiler showing detail of the heating units and connections. Fig. 3 and Fig. 4 are views of the generator and switchboard after installation.



Plan and Elevation of Electric Steam Generator.



Detail of Construction of Electric Steam Generator.

General News and Personal Mention

S. W. DIETRICH LEAVES THE ALTON.

On August 1 Mr. S. W. Dietrich resigned his position as Chief Electrician of the Chicago and Alton Railroad to accept that of Superintendent of Operation of the San Joaquin Light & Power Co., at Fresno, Cal. It is just five years since Mr. Dietrich entered the service of the Alton and in that time he has made an unusually good record. As an exponent of the principles of efficiency, he reduced the cost of electric car lighting from $45 a month to $17 a month and at the same time improved the quality to the extent that light failures instead of occurring regularly became almost unknown. Mr. Dietrich was a strong advocate of the ampere-hour meter and attributes much of his success to its use.

The change of work which he has recently made is not so radical as it might at first seem, as Mr. Dietrich was in the employ of the California company before he went into railroad work. He now has complete charge of the operation of an electric service corporation covering an area of over 30,000 square miles—the entire central portion of the great San Joaquin valley.

Mr. Dietrich wishes to be remembered to all his old friends in the car lighting field and we are sure we are expressing the sentiments of all in wishing him the greatest measure of success in his new work.

CHICAGO STREET SUBWAY LIGHTING

The committee composed of representatives from the electrical departments of the railroads and representatives of the electrical department of the city of Chicago has been appointed to confer on the subject of lighting street subways under railway elevations. It is not yet settled whether this lighting should be done by the city or by the railways. A test case between the Pennsylvania Railroad and the City of Chicago is now pending in the Illinois Supreme Court and it is expected that a decision will be handed down in October. Regardless of the decision, however, it is desirable that a method of lighting, practical, economical and satisfactory to the city should be selected, and this is what the committee is endeavoring to do.

There is more difficulty in this than might at first appear on account of the widely varying character of the subway structures. It is probable that tungsten units of medium size will prove the best solution of the problem.

On the face of it it seems a rather arbitrary demand on the part of the city that the railways should light the streets, especially as some of the subways are located on the outskirts of town where the traffic is almost negligible.

GREAT WESTERN ACTIVITIES.

The Chicago Great Western Railway is making the following additions to the electrical equipment of its shops at Oelwein, Iowa.

Three 400 h.p. boilers.

One 200 k.w. 220-volt continuous current generator, driven by reciprocating engine.

One transfer table.

One electrically operated gantry crane, 100 tons capacity for handling Mallet locomotives.

Motor-driven triplex pumps for shop water supply.

Link-belt electrically operated coaling station.

The machine tools of the woodworking shop are being changed from group to individual motor drive, which involves the installation of 27 new motors.

These improvements are being made by the Great Western's electrical department. The equipment is furnished by the General Electric Co., Crocker-Wheeler Co. and Westinghouse Electric & Manufacturing Co. It is expected that they will be completed by Nov. 1.

NEW MAIL CARS ON N. Y. C. LINES

Fifty new lighting equipments for mail cars are being put in service on the New York Central lines. The Lake Shore gets 15 of these, the New York Central 15 and the Michigan Central and Big Four 10 each. Each car is equipped with 13 50-watt tungsten lamps under steel reflectors, giving approximately 5-foot candles on the distributing plane, with a consumption of 1.2 watts per sq. ft. The reflectors are furnished by the Safety Car Heating & Lighting Co. and the axle equipments are of the Gould Simplex 30-volt type.

The Chicago & Northwestern Railroad is installing electrical equipment for lighting its new 58 stall wood roundhouse at Butler, Wis. Sufficient capacity is provided to take care of the power requirements of the coaling station, etc. Two 440 volt, 3-phase, 60-cycle alternators, one of 250 k.v.a., and the other 175 k.v.a., are installed. The lighting will be done at 110 volts. The roundhouse will be divided into four sections and a different lighting system installed in each with a view to determining which system is best.

A large installation of Cooper-Hewitt mercury vapor lamps has just been made in the Chicago shops of this company.

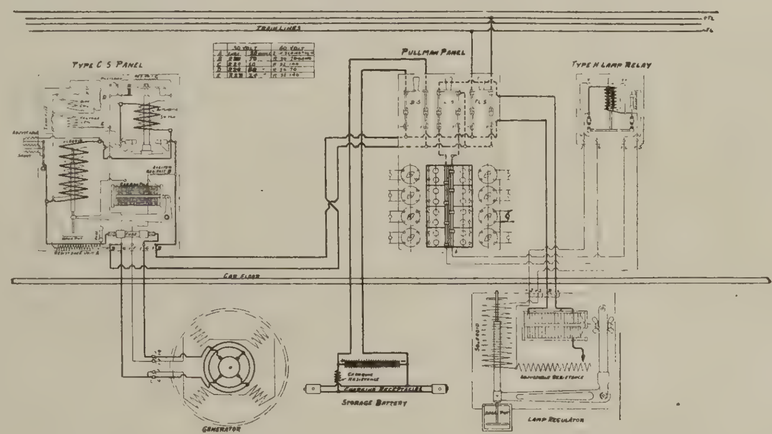
The Oneida Steel Pulley Company, Oneida, N. Y., has recently placed on the market the Keystone Railroad Pulley, specially designed for axle lighting work. This pulley is made in all diameters from 16 in. to 23 in. with the standard 7½ in. bore. It has been designed for maximum strength and the greatest measure of accessibility. The same company has also developed a corrugated steel bushing which fits either a straight or tapered axle and gives a strong grip, at the same time being much lighter than the cast iron bushing.

A branch office of the Federal Miniature Lamp Company, 812 Hippodrome building, Cleveland, Ohio, has been established at 301 Fort Dearborn building, Chicago, Ill. The new office is in charge of Mr. Frederick S. Armstrong, who has had about fifteen years' experience in the lamp business.

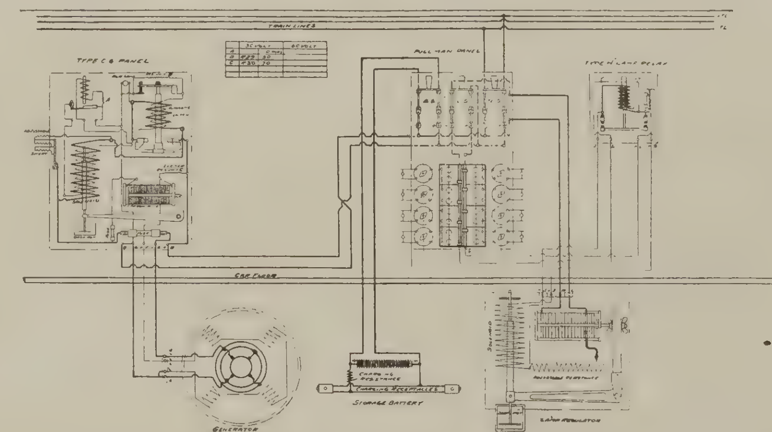
The Chicago warerooms are located in the Cambridge building, Randolph St. and Fifth Av. More than 100,000 miniature lamps, embracing scores of different styles and types, are here carried in stock.

Wiring of U. S. L. & H. Co. Axle Lighting Equipments

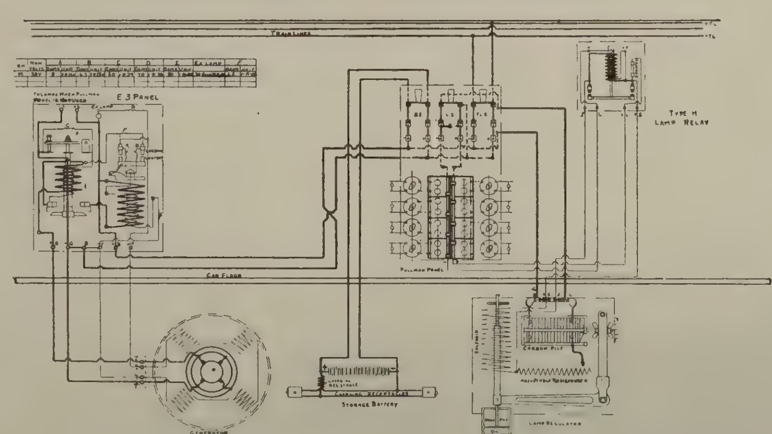
Wiring Diagram U. S. Light & Heating Co. Complete Equipment. Panel,, "C-5"; Lamp Regulator, "C-3"; Lamp Relay, "H"; Pullman Panel; Train Lines.



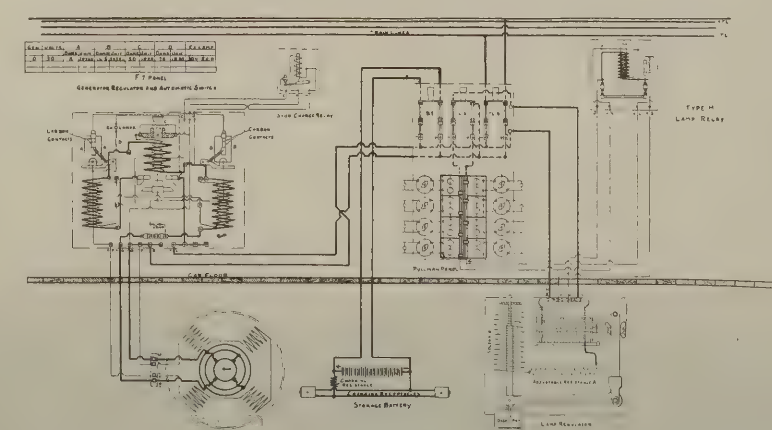
Wiring Diagram U. S. Light & Heating Co. Complete Equipment. Panel, "C-6"; Lamp Regulator, "C-3"; Lamp Relay, "H"; Pullman Panel; Train Lines.



Wiring Diagram U. S. Light & Heating Co. Complete Equipment. Panel, "E-3" with Shunt Coil; Lamp Regulator, "C-3"; Lamp Relay, "H"; Pullman Panel; Train Lines.



Wiring Diagram U. S. Light & Heating Co. Complete Equipment. Panel "F-7"; Lamp Regulator, "C-3"; Lamp Relay, "H"; Pullman Panel; Train Lines.



RAILWAY ELECTRICAL ENGINEER

Official Journal of the Association of Railway Electrical Engineers.

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

The Engineer and the Public.

IS the Engineer a savant specially privileged by his learning to devote his time and energy to working out the higher mathematical problems which delight the admirer of logical thinking carried to the point of absurdity or is he nothing more than a public servant, owing his time and best thought to the solution of the practical difficulties of the common people?

Mr. Frank B. Rae raised this question at the Illuminating Engineering Society convention last month. He said, in effect, that there was among engineers, as among the other higher professions and arts, a tendency to deal with the ideal rather than the practical. He made a plea for simplicity and the reduction of scientific data to the form which would give it widest currency and use. Specifically, he asked for a few simple formulas for calculating the amount of light required for certain common conditions. He wanted among other things a table showing the comparative absorption of different colored walls. With all the papers and discussions before that eminent society no simple definite conclusions had been reached. The rule of thumb is still the formula by which nine-tenths of all lighting installations are calculated.

The gentlemen at the convention were somewhat nettled at Mr. Rae's remarks. They said if the benighted public would come to their meetings it would learn something. They said also that so far as they individually were concerned, they would be at a loss to know what to say in answer to Mr. Rae's specific demands. So many indeterminate factors affect the accuracy of results—it is necessary to proceed with great caution, etc. In view of which there may be curiosity as to just what benefit the public would gain from being present.

The attitude of these members was natural. They were doing careful conscientious work. They had a scientist's horror of hasty conclusions, inaccuracies and rough approximations. But they lost sight of the fact that it would be a far greater achievement and do far more good to improve half the world's lighting 25 per cent than to improve a hundredth of the world's lighting 100 per cent. The point of view they showed in replying to Mr. Rae's paper proved the truth of the criticism it contained.

Viewed broadly there can be no question but what it is the duty of engineers to give to the world as quickly as possible the results of their efforts for scientific improvement. These results may fall far short of the ideal. But if they are better than what we have, that fact justifies there being given out. If a thing is good it is better the more people know about it.

The same tendency to carp and quibble over abstract scientific questions has been manifest in the meetings of the American Institute of Electrical Engineers, especially at the sessions on electric traction. At the meeting in Chicago last June someone grew tired of it and arose and spoke something like this: "Here are two systems of electrification. They will both work. They are both working. Both are good. Why not stop quarreling about which is better and get out and make them both work some more?" Which struck us as about the most valuable idea expressed at that meeting.

It is safe to say that no railway electrical engineers are in danger of forgetting the realities to speculate about the ideal. They have too much to do. They know that they are servants of the public and that what they are getting paid for is to give the public the best service possible with the means at their disposal. They may regret that these means will not permit the service they would like to give. But, however handicapped, they will keep on making improvements. And that is what is important. That is what counts.

Why?

SO much has been written about the scientific management of the Santa Fe Shops at Topeka that we were a little surprised to find there complete new freight car shops destitute of electric drive. Of course there may be some good reason for it but we thought it pretty generally conceded that electric drive for a shop of this sort was safer, more efficient and more economical than shaft drive. Perhaps the scientific management extended only to handling employes.

Can the Carbon Come Back?

In writing of the development of incandescent lamps Mr. J. E. Randall suggests the interesting possibility that one of the developments of the future may be a reversion to the carbon filament. He points out that while metallic filaments possess great advantages in point of efficiency, the carbon lamp is much superior in point of first cost. There is, he thinks, a chance that the efficiency of the carbon may be improved so that it can again compete with the tungsten. It may be so. In the eight years from 1902 to 1910 an improvement of 8 per cent was noted in the quality of carbon lamps. In the four years from 1907 to 1911 metallized, or "Gem" filament lamps were improved 33 per cent. It is probably true that during these years the development of metallic filaments occupied nearly all the time and attention of the investigators. Had they put an equal effort on the carbons it is quite probable that the improvement would have been greater. There will come a time when the possibilities of improvement in metallic filaments will have been exhausted. Then, if attention is once more concentrated on the carbon filament, it is quite possible that this old and tried illuminant may come back with a vengeance.

ASSOCIATION NEWS.

This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.

It will be open to communications pertinent to association matters. Any member who has anything to say to the other members is invited to make use of this column for that purpose. Such communications should be addressed to the secretary of the association.

At the September meeting of the Executive Committee the following men were admitted to the Association:

A. M. Burgenheim, 801 Julia St., New Orleans, La.
John M. Craig, 1111 Fourth Ave., Altoona, Pa.
Wm. G. Davis, Room 1430, 30 Church St., New York.
R. M. Lytle, 7114 Cottage Grove Ave., Chicago.
F. L. Matschek, 2411 Howard Ave., San Francisco.
D. B. Pastorius, 74 Fulton St., Rahway, N. J.
J. H. Wickman, 298 Walker Ave., Memphis, Tenn.

CONVENTION PROGRAM.

As all readers of this journal are aware, the Fourth Annual Convention of the Association of Railway Electrical Engineers will be held at the La Salle Hotel, Chicago, Nov. 6-10. Secretary J. Andreucetti has announced a tentative program of the meetings as follows:

TUESDAY, NOV. 7.

Morning Session, 10 A. M.
- Address of President.
- Report of Secretary-Treasurer.
- Unfinished Business.
- New Business.

Afternoon Session, 2 P. M.
- Report of Committee on Data and Information.
- Report of Committee on Ventilation.

WEDNESDAY, NOV. 8.

Morning Session, 9:30 A. M.
- Report of Committee on Standards.
- Report of Committee on Improvements.

Afternoon Session, 2 P. M.
- Report of Committee on Shop Practice.
- Paper on "Insulation," by K. R. Sternberg.

THURSDAY, NOV. 9.

Morning Session, 9:30 A. M.
- Report of Committee on Specifications.
- Paper on "The Gas Electric Car."

Afternoon Session, 2 P. M.
- Report of Committee on Train Lighting Practice.
- Report of Committee on Illumination.

FRIDAY, NOV. 10.

Morning Session, 10 A. M.
- Report of Committee on Accounts and Reports.
- Report of Auditing Committee.
- Election of Officers for ensuing year.

Afternoon Session, 2 P. M.
- Paper on "Industrial Trucks for Railway Service," by T. V. Buckwalter.
- Informal Discussion.

This program is subject to minor changes.

ENTERTAINMENT.

The entertainment features are scheduled as follows:

Monday night, 8:30 P. M., an informal dance in the Red Room on the 19th floor of the La Salle. This is one of the most enjoyable features of the convention. It is the place to renew old acquaintanceships and form new ones. Along with the dance goes a reception. The stunt is not called a reception, though, because that word has a kind of stiff and formal sound—makes you think of those long sad lines where no matter what your name is at the start it is always Smith or Jones by the time you reach the finish. This is nothing like that. Everything is strictly informal and anyone appearing in a dress suit will be sent out for the cigars. Last year a good many missed out on the opening. Also there was a painful scarcity of ladies. Be sure to be there this year and bring your lady because she enjoys dancing even if you aren't as handy on your feet as once upon a time. W. M. (otherwise "Billy") Lalor will have charge of this affair and see that the floor is well waxed.

Tuesday afternoon while their worse halves are deep in the technicalities of ventilation, that will be the least of the ladies' troubles because they will be skimming through the Chicago parks on an automobile tour. The Ladies' Man who went along last year says that this was a very enjoyable occasion for the ladies as well as for him. After a thorough skimming, the cream of the convention will return to the hotel whence they are supposed to have started at 2:30 sharp. Otis B. Duncan, the only living man who has ever been seriously considered a rival of Barney Oldfield, will be chief chauffeur of the expedition.

Tuesday night will be Ladies' Night at the Manufacturers' Exhibit and if said manufacturers are wise they will lay in an ample stock of Lowneys for the occasion. Believe us, there are few women who do not prefer something good in a chocolate insulation to the slickest piece of electrical machinery ever put together.

Wednesday afternoon is the regular time for the midweek matinee and it is needless to say that the ladies will have the pleasure. At least it ought to be a pleasure. W. F. (alias "Billy") Bauer has not yet decided which show it will be but you can rest assured it will be a good one. Whatever its drawbacks may be Chicago does have some good shows.

Wednesday night the Car Lighting Club will do it-

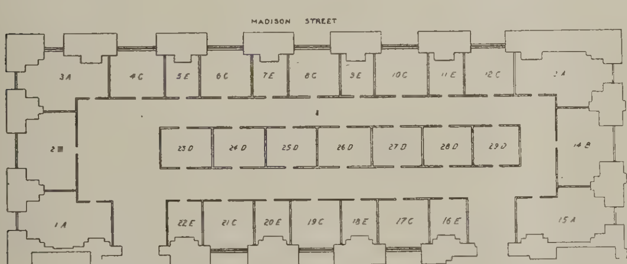
self the signal honor of entertaining the Association. The entertaining will be done in the Red Room and will begin at 8:30. The feature will be a talk by Mrs. M. S. Woodward on the "Siege of Pekin." Back in 1900, if you remember, there was something doing in China in the shape of a Boxer uprising. The Boxers surrounded the city of Pekin and planned unpleasant finishes for the Europeans and Americans, whom they affectionately termed "foreign devils." Eventually Pekin was relieved by the troops of the allied nations but not until the heads of the civilized families there had been occasioned considerable worry. Mrs. Woodward was a guest of U. S. Minister and Mrs. Conger in Pekin at the time of the uprising, and she secured a remarkable series of photographs, many of which have been made into lantern slides and will be thrown upon the screen to illustrate her lecture.

Thursday evening at seven o'clock, the oyster cocktails which mark the opening of the annual banquet given by the Supply Manufacturers' Association to the railway men will put in an appearance. The usual high standard of edibles will be maintained and there will be toasts but—and this is very important—these toasts will be thin, crisp slices, soon over. By 10 o'clock it is expected that everyone present will have taken all the nourishment he needs and also have been helped to all the "feast of reason and flow of soul" he cares for. At that hour the wreckage will be cleared away and dancing will be in order until plenty late. This dance also is informal although dress suits will be tolerated. Geo. Berger is in charge of the evening's excitement.

All entertainment features are handled by the Railway Electric Supply Manufacturers' Association. Geo. H. Porter is Chairman of the Committee on Entertainment.

EXHIBITS.

As stated last month, the entire grand ball room on the 19th floor of the La Salle will be devoted to exhibits. There are 29 spaces, ranging from 70 to 182 sq. ft. in size and selling for 45 cents a square foot which includes all expense of decoration. The cut



Plan of Exhibit Space at November Convention.

shows the layout of the exhibit room. There is still time to get one of these spaces but action should be taken at once. A drawing to determine the allotment of space will be held on October 16th. All those contemplating exhibiting should write at once to W. E. Ballantine, Chairman of Exhibit Space, 436 South Dearborn street, Chicago, Ill.

CAR LIGHTING CLUB.

The first regular meeting of the Car Lighting Club was held at the Kuntz-Remmler restaurant, 424 South Wabash Ave., on the evening of Sept. 20. This will be the regular meeting place of the Club until further notice. About 50 members were present to listen to a paper by Geo. R. Shirk, Chief Electrician of the Chicago Great Western Railway, on the subject of pulleys.

Mr. Shirk made a plea for larger diameters of pulleys. He said that a two years' test showed that 75 per cent of all axle-lighting belts were lost or cut to pieces. To his mind this is largely because of the small sized pulleys used, which greatly increase the strain on the belt fastening. He was also of the opinion that a 5/16-in. crown on the armature pulley would do away almost entirely with the shifting of the belt from side to side which results in its being cut to pieces.

F. E. Hutchinson (Rock Island) spoke at some length on his experience with axle-lighting belts. He said that 500 high grade belts averaged 21,000 miles each of actual service and 700 others averaged 12,000 miles each. Since the full wearing capacity of these belts was not being realized, why would not cheaper belts be more economical? A comparative test to determine the relative economy of cheap and high priced belts is now being made. In Mr. Hutchinson's opinion the real cause of trouble with belts is imperfect alignment of the two pulleys. Improvement in this regard is a matter of changing the generator suspension. If the generator were placed inside the truck sill so as to be an integral part of the truck, perfect alignment could be secured and belt troubles would be much less serious than at present.

Geo. B. Colgrove (Illinois Central) said that the experience of some eastern roads showed that 50,000 miles of service could be gotten out of axle-lighting belts. He said that greater life had been attained by 4-ply than by 5-ply belts, presumably on account of their greater flexibility.

The Canadian Pacific uses a balata belt with a fastening made by turning up the two ends and clamping them together with small bolts fitted into curved steel sheets. With this arrangement it is claimed that 100,000 miles life is attained in actual service.

There was some discussion regarding stop charge devices for use with axle equipment. H. G. Myers (Santa Fe) reported some difficulty with these on account of improper setting of the automatic switch. The switch failed to close until the generator voltage had risen to a point which operated the stop charge device when it did close. The result was that the stop charge operated all the time and the batteries received no charge. This, of course, is a matter of adjustment but these adjustments should be carefully made before equipments having the stop charge device are placed in service.

The next meeting of the Club will be held October 18 at the same place and the usual hour—six-thirty. The principal paper of the evening will be by R. C. Lamphier, of the Sangamo Electric Company, who will talk on Ampere-Hour Meters.

In place of the regular November meeting, a special entertainment and ladies' night will be given during the Annual Convention of the Association of Railway Electrical Engineers. This meeting will be held in the Red Room on the 19th floor of the La Salle Hotel. The special attraction of the evening will be an illustrated lecture by Mrs. M. S. Woodward on the "Siege of Pekin." Mrs. Woodward was a guest of U. S. Minister Conger when the Americans and Europeans were confined within the city. She secured there a remarkable series of photographs which have been worked up as lantern slides and will be exhibited during the lecture. Special invitations to attend this meeting of the club will be extended to all prominent railway men in the vicinity of Chicago.

Recent Developments in Incandescent Lamps

By J. E. RANDALL

By common usage, the name incandescent electric lamp has been limited to a lamp whose light source is the glow of a wire heated in vacuo by electric current. This paper will not use the name in any broader sense.

Incandescent electric lamps may be divided into two classes, depending upon whether their light-giving elements, that is, their filaments, are made of carbon or of metal. At present the best examples of each class stand rather far apart both in appearance and in other features, although both are designed for the same service. One may be replaced by the other for nearly every use.

Lamps with carbon filaments have been supplied without any change in appearance for over eleven years. Within that period one notable improvement was introduced, namely, the metallized filament. Among the lamps with metal filaments, there has been, within the last five years, a procession of developments beginning with the osmium filament, the tantalum wire filament, the pressed tungsten filament, and ending with the drawn wire tungsten filament. The author shall attempt to briefly review the advances that have been made in the quality of the most prominent members of the two classes.

Carbon Filament Lamps.

The changes in quality of the regular carbon filament lamps of all standard wattages are shown in the subjoined table. Each year's quality is shown in comparison with the average of 1902.

Year	1902	1904	1906	1907	1908	1909	1910
Per cent. of 1902	100	98.4	96.9	96.9	100	103.1	107.8

A sag in quality is indicated from 1904 to 1907. This is accounted for by the larger proportion of wattages below 50 and above 100 that were produced during those years. The large and small wattage lamps are known to be inferior to those between 50 and 100 watts. Within recent years the production of high wattage lamps has diminished and doubtless will decrease still further. The proportion of low wattage lamps has been maintained and has held back the progress of average quality during the last three years. As a matter of fact, nearly every wattage shows a substantial improvement within the eight year period.

No changes have been made in the processes of manufacture. The record exhibits the results of systematically following each detail, of rigid inspection, of thorough, exact and extensive tests, of the immediate use of the latest developments in equipment and the unhesitating discard of unsuitable equipment, of the services of trained operatives. The best lamps of ten years ago were as good as the best of the present year. The average has arisen due to the elimination of defectives.

The metallized carbon filament lamps, which are known as Gems, have made the advances shown by the following record: Calling the product of 1907 equal to 100; that of 1908 is 121; that of 1909 is 130; that of the past year is 133.

All conditions favorable to advancement of the regular carbon filament lamps were of similar assistance to the Gems. A discovery in connection with the preparation of the carbons for these lamps resulted in a decided improvement in 1909. Heretofore, wattages lower than 50 have not been made successfully. Recent experiments show that wattages as low as 30 can be made.

The Gem lamp shows a sufficient superiority in quality over the regular carbon filament lamp to justify its more extensive use.

Metal Filament Lamps.

As the developments in three metal filament lamps have been rapid, recent and thoroughly published, no extended description will be given in this paper.

The osmium lamp marks the beginning of development of metal filament lamps. It reached a successful commercial stage in Europe. Its great fragility and the difficulties met in fashioning the filament would, no doubt, have been eliminated had its development not been arrested by the limited supply of osmium and by the advent of the tungsten filament.

The tantalum, nearly coeval with the osmium, was handicapped neither by fragility nor meager supply of metal. It is worthy of mention as an example of an article upon whose production years of research had been spent, upon whose design lavish experiments had been made. When first offered to the public, its design was finished and its qualities were thoroughly known. The inferior performance, due to offsetting, on alternating current was announced at the time the lamp was announced. The mechanical weakening of the tantalum wire, due to offsetting when kept on alternating current, has prevented the general introduction of the tantalum lamp in this country.

This lamp, however, was the first production of a real drawn wire lamp and its development required a construction of the filament supporting element different from any that had been used heretofore. The design of support employed in the tantalum lamp has been followed, with slight modifications, in the drawn wire tungsten filament lamp. The tantalum lamp cannot continue to compete with the drawn wire tungsten filament lamp in its present form.

The tungsten filament lamp was the immediate successor of the osmium lamp, and one of the most successful methods of producing the tungsten filament is based upon the process used in making the osmium filament. The completely developed process, however, has departed considerably from the method originally used, and it is doubtful whether the osmium filament could be produced by the methods now employed in the manufacture of the pressed tungsten filament. Various experimenters quickly discovered other methods of producing pastes from which tungsten filaments could be pressed. The most successful commercial methods are, however, really variations of the original Auer process.

The superiority of the metal tungsten for a lamp filament was immediately recognized because of its extremely high melting point and because its boiling point is not greatly below its melting point. The brittleness of the pressed filament, especially when it is cool, has been a serious drawback to the general use of the lamp. The attachment of the filament rigidly to the circuit connections and to the intermediate

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A paper read at the fifth annual convention of the Illuminating Engineering Society, Chicago, September 25-28, 1911.

connections between the filaments has probably been the chief cause for filament breakage in these lamps. The arced joint, while it was perfect electrically and mechanically, held the filament ends rigidly. Any jar to the lamp tended to make the filament vibrate and usually to break close to the joint. The schemes that were devised for avoiding this filament breakage were legion, but the author believes he is safe in saying that the loose contact at the bend of the filament with a support that was rigid made the hardiest lamp of the pressed filament type

One of the most successful devices for preventing the breakage of filaments was that of introducing a short piece of piano wire between the center rod and the stem seal. This supported the filament structure with remarkable flexibility and prevented breakage from blows on the lamp in almost any direction. A slight blow upon the base of the lamp was invariably fatal and this one weak feature served to prevent the general introduction of this method of support.

The pressed tungsten filament is not ductile when cold, no matter by what process it may have been produced. Although pressed filaments have been made that could be bent and that would take a permanent set if bent, these filaments were not truly ductile. It was natural, therefore, that immediate effort should be made to develop a quality of tungsten sufficiently ductile to be wrought into the form of wire. There was nothing to prevent success in this endeavor except lack of knowledge. It had been demonstrated that tantalum, which had been known as an extremely brittle metal, could be so improved in purity that it would be ductile. This knowledge would naturally lead to the belief that many of the metals which had been considered as non-ductile could, if properly prepared, be made into ductile form. An epitome of the progress in developing ductile tungsten will read something like this:

In 1907 it was hoped that it would be possible to produce ductile tungsten; in 1908 it was believed that it would be possible to produce ductile tungsten; in 1909 experimenters were sure that ductile tungsten could be produced; in 1910 it had been proven beyond doubt that ductile tungsten could be produced; in 1911 ductile tungsten was produced on an extensive commercial scale.

It is generally believed that the presence of carbon in tungsten is the cause of its brittleness. One well known process for making pressed tungsten filaments does not involve the use of carbon, yet filaments produced by this process are as brittle as are filaments made by the use of carbon. As a matter of fact, the best pressed tungsten filaments have been those made by processes involving the use of carbon, yet they contain an amount of carbon so small that it can only be detected by the most delicate tests. For instance, filaments which are known to contain less than 0.005 per cent. carbon are no more ductile than those which are found to contain 0.1 per cent. The elimination of carbon tended to reduce the length shrinkage of filaments when lamps were burned. You will doubtless recall that filaments produced in 1908 and 1909 sagged excessively and that the filaments often short-circuited due to this sag. The slack producing this sag was necessary because of the filament shrinkage. During the year 1909 decided improvements were made in this respect, and the basis of these improvements was the more complete elimination of carbon from the tungsten filament.

The progress during 1909 and 1910 did not indicate a material decrease in the fragility of the pressed filament.

The Drawn Wire Tungsten.

It was evident, therefore, that to make the tungsten filament lamp a universal lamp, it would be necessary to have the filament in the form of wire which was sufficiently ductile to be wound, when cold, upon a spider structure. The drawn tungsten wire has met this need. While the wire before being placed in the lamp is amply ductile for the purpose of winding upon the spider and for all other manipulations needed in making the lamp, it loses much of this ductility when current is passed through it in a vacuum. The method of supporting the wire on the spider and of attaching it to the circuit terminals are, therefore, important factors in the hardiness of the lamp.

The wire may be considered to consist of pure tungsten. Chemical analysis does not find other elements. The ratio of resistance hot to resistance cold is as high as can be found in any other form of the metal. The specific gravity is higher than that found for the pressed filament. The current and the candle-power peaks are low.

The structure of the metal appears to be fibrous. It changes to the crystalline form during the burning life of the lamps. This change may occur in some portions of a filament and not in others. Frequently, after the full burning life, small sections of filaments will be found that show ductility.

Tests indicate that the wire is less brittle at every stage in the life of a lamp than are pressed filaments. There is no offsetting, either on direct or alternating-current. The surface is the same in appearance, after the lamp has been burned, as that of a pressed filament. It looks as if the wire had been cracked into irregular pieces and as if a cement of the same material had filled up the cracks. No fissures at the surface and no cavities in the body have been found.

While the wire, before being placed into the lamp, may be ranked with the toughest steel in tensile strength, ductility and elasticity, the decay of these properties after it is in the lamp makes it necessary to handle these lamps with reasonable care in order to prevent breakage. Breakage in transportation and handling compares with that for carbon filament lamps. Operatives in the lamp factories transfer lamps having wire filaments from operation to operation the same as if they had carbon filaments.

Another feature in which the drawn wire is superior is the wide range of sizes suitable for use. A piece of wire may be drawn to a size suitable for a 6.6 amperes series burning lamp or it may be drawn to a size suitable for a 20-watt, 110-volt multiple lamp. It will, when drawn to the proper diameter, be equally satisfactory for the largest or the smallest lamp. In addition, the wire may be shaped into helices, spirals or zig-zags; thereby concentrating the light-giving element into a small volume. The latest automobile lamp is an example.

The number of contacts between the filament and supports, including terminals, as well as the size and material of these supports, will affect the performance and physical hardiness of a lamp.

The following results were secured from three series of tests in each of which more than 300 drawn wire tungsten filament lamps were used:—

No. of contacts	11	13	15
Comparative strength, by pendulum test—			
Copper	91.5	100	96.5
Molybdenum	....	...	93.0

Comparative performance at normal efficiency—
Copper 99.4 100 96.1
Comparative life at extreme temperature—
Copper 107.0 100 87
Molybdenum 103

The lamps were standard in voltage and all were 40 watts. They were identical except in the number of filament contacts. The results of the first and second tests confirm one another in indicating that 13 contacts are most satisfactory.

While no record is shown for molybdenum support lamps at normal efficiency, such lamps were tested, but their performance was much more poorer than the corresponding copper support lamps.

The comparative lives at extreme temperature show that 11 contacts are better than 13 and that 13 are better than 15. Also that 15 molybdenum contacts are better than 13 copper, but inferior to 11 copper. These results are not in consonance with the results at normal efficiency. It is reasonable to believe that tests at, or near, normal efficiency indicate more accurately the behavior of lamps in service than do those at high temperatures. It has been observed that the wire in lamps burned out when at high temperature remains more ductile than the wire in lamps burned out at normal temperatures. The early failure of 15 contact lamps would not be explained by mechanical weakness. The wires usually "burned out," or melted, between the supports. The melting of the wire at the point of highest temperature has really controlled the life record of this test. The diameter of all copper supports was the same. The diameter of the molybdenum was 40 per cent of that of the copper. Supports of copper having diameters 30 per cent smaller and 30 per cent larger than the size used in the above tests both showed a lower strength by pendulum test. The author cannot explain why this should be so, but the tests were convincing.

Having traced recent developments up to the latest, it may not be amiss to consider the future. If the progress in lamp development may be gaged by the highest filament temperature at which each new lamp will show a given performance, one has a rational measure. For example, if 90 per cent of the theoretical candlepower hours are developed in 1,000 hours burning, candle maintenance and mortality both considered, the advance from the raw carbon filament lamp to the tungsten filament lamp will show something as follows:

Raw carbon filament lamp (cellulose carbon) . 100
Treated carbon filament lamp 119
Metallized carbon filament lamp 149
Tantalum filament lamp 206
Osmium filament lamp 270
Tungsten filament lamp 359

This comparison excludes many items, such as process difficulties, lack of wattage range, lack of voltage range, lack of suitability for both alternating- and direct-current, cost, etc., which affect commercial values. It is not a comparison of commercial values, although it is a comparison of the most important element in commercial values, namely, the energy wasted in doing equal work.

The change introduced by the metal filament lamp is noteworthy. Can carbon, with its many good qualities, reach or pass the record set by metals? The carbon deposited upon the treated carbon filament, when metallized, is dense, somewhat flexible, has a low vapor tension, has a fine quality of surface and has a cold specific resistance that is about 4 per cent of carbon made from cellulose. All these qualities are favorable. Their further development may again place carbon in the race.

GREAT GROWTH IN ELECTRICAL INDUSTRY.

The preliminary report of the Census Bureau for the year 1909 shows a remarkable growth in all branches of the electrical industry. Comparative figures for 1899, 1904 and 1909 show an increase in value of electrical products of 130 per cent during the decade. The increase in value of storage batteries was nearly 200 per cent, and of incandescent lamps more than 400 per cent. The value of the incandescent lamps made in 1909 exceeded that of all generating machinery put together. The largest single item is that of insulated wires, which aggregated about $50,000,000, or 21 per cent of the total.

Assuming an average value of 30 cents each for the incandescent lamps there must have been about 40,000,000 of these manufactured in 1909. This is easily believable when one stops to consider that one railroad buys over 2,000,000 lamps a year. Of course this one road is the largest single consumer in the country, but there is no doubt that the railroads buy over 25 per cent of all incandescent lamps that are sold.

An increase in value of nearly 500 per cent in electrical conduits as compared with 240 per cent for wires shows that their use was extended considerably during this period.

The figures follow:

ELECTRICAL MACHINERY, APPARATUS AND SUPPLIES—PRODUCTS, BY KIND, QUANTITY, AND VALUE: 1909, 1904, AND 1899.

ITEMS.	1909	1904	1899
Number of establishments	[1] 1,255	[1] 912	[1] 581
Total value of products	$243,967,000	$159,551,000	$105,832,000
Dynamos:			
Number	16,791	15,080	10,527
Total kilowatts	1,405,951	996,182	578,124
Value	$13,081,000	$11,084,000	$10,473,000
Dynamotors, motor generators, boosters, rotary converters and double-current generators	$3,155,000	$1,740,000	$380,000
Transformers for light and power	$8,801,000	$4,469,000	$2,963,000
Switchboards, panel boards, cut-out cabinets for light and power	$5,972,000	$3,766,000	$1,847,000
Motors:			
For power—			
Number	244,123	79,877	85,604
Horsepower	1,623,677	678,910	515,705
Value	$18,306,000	$13,121,000	$7,551,000
For automobiles—			
Number	2,796	1,819	3,017
Horsepower	12,471	19,907	8,220
Value	$294,000	$153,000	$192,000
For fans—			
Number	199,113	102,535	97,577
Horsepower	178,033	30,796	12,766
Value	$2,451,000	$1,168,000	$1,055,000
For railways, elevators, and miscellaneous services, including supplies and parts—			
Number	58,698	22,112	23,582
Horsepower	859,237	763,399	684,791
Value	$11,036,000	$7,929,000	$10,707,000
Storage batteries, including parts and supplies:			
Weight of plates in pounds	23,119,331	16,113,073	([2])
Value	$4,678,000	$2,646,000	$2,560,000
Primary batteries including parts and supplies:			
Number	34,333,531	6,623,162	2,654,765
Value	$5,934,000	$1,598,000	$1,119,000
Arc lamps:			
Number	123,543	195,157	158,187
Value	$1,707,000	$1,574,000	$1,828,000
Searchlights, projectors, and focusing lamps	$936,000	$115,000	$226,000
Incandescent lamps:			
Carbon filament, gem, tantalum, tungsten lamps	$13,839,000	$6,308,000	$3,442.000
Decorative and miniature lamps, X-ray bulbs, vacuum tubes, etc. (also includes glower lamps and parts, and vacuum and vapor lamps)	$1,876,000	$645,000	$73,000
Sockets, receptacles, bases, etc	$4,522,000	$2,011,000	$594,000
Electric lighting fixtures of all kinds	$6,128,000	$3,295,000	$3,751,000
Telegraph apparatus	$1,957,000	$1,111,000	$1,642,000
Telephone apparatus	$15,547,000	$15,864,000	$10,512,000
Insulated wires and cables	$50,338,000	$34,520,000	$21,202,000
Electric conduits	$5,098,000	$2,416,000	$1,066,000
Annunciators—Domestic, hotel, and office	$236,000	$186,000	$225,000
Electric clocks and time mechanisms	$352,000	$374,000	$132,000
Fuses	$1,002,000	$868,000	$595,000
Lightning arresters	$940,000	$587,000	
Rheostats and resistances	$2,675,000	$933,000	$1,187,000
Heating, cooking, and welding apparatus	$1,003,000	$396,000	
Electric flatirons	$951,000	([2])	([2])
Electric measuring instruments	$7,800,000	$5,005,000	$1,842,000
Electrical therapeutic apparatus	$1,116,000	$1,037,000	([2])
Magneto-ignition apparatus, sparks, coils, etc.	$6,080,000	$678,000	([2])
Electric switches, signals, and attachments	$5,384,000	$1,451,000	$1,130,000
Circuit fittings of all kinds	$1,081,000	$3,525,000	([2])
All other products	$34,000,000	$26,179,000	$15.384,000
Amount received from custom work and repairing	$5,691,000	$2,799,000	$2,064,000

[1] Includes establishments engaged primarily in the manufacture of products not identified with the electric industries, but incidentally making electrical machinery, apparatus, and supplies, as follows:

Year.	Number of establishments.	Value of product reported.
1909	246	$22,660,000
1904	128	18,742,000
1899	....	13,397,000

[2] Not separately reported.

Electric Locomotives for the Hoosac Tunnel

The Boston & Maine Railroad Company has had in service since the latter part of May five Westinghouse electric locomotives for freight and passenger service at the newly electrified Hoosac Tunnel. One of these locomotives hauls each train and its steam locomotive with banked fire through the tunnel. This practically eliminates the obnoxious steam, smoke and gases incidental to steam operation. These locomotives have

Boston & Maine Combination Freight and Passenger Locomotive.

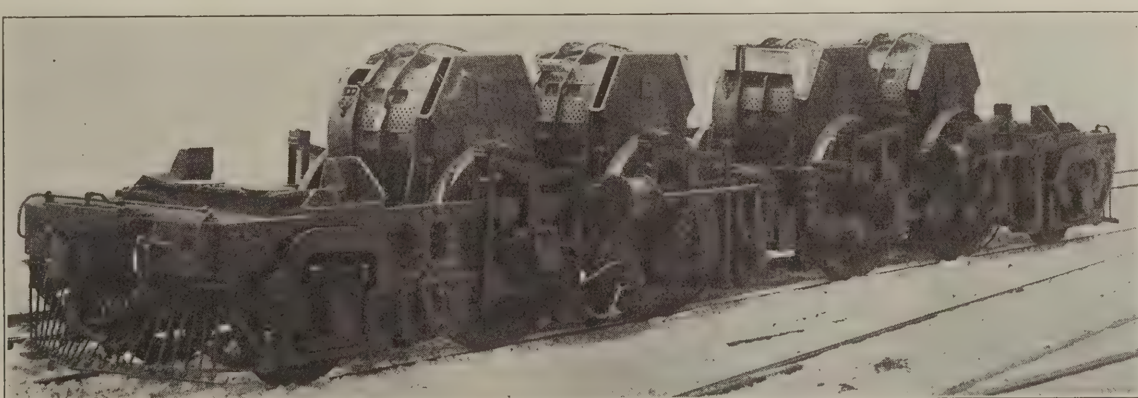
four geared motors, twelve wheels, and are designed for operation on 11,000 volts alternating current. Two are used for heavy freight service and the remaining three for combination passenger and light freight service.

The electrified zone extends from Hoosac Tunnel Station, Mass., to North Adams, Mass., a distance of 7.92 miles, of which 4.75 miles are within the tunnel. The central zone of the tunnel has an almost level track 1,200 feet in length, with an ascending 0.5 per cent grade up to this level track from both the east and west portals.

The passenger locomotives were designed to handle trains having a maximum weight of 730 tons, inclusive of steam and electric locomotives, and to maintain a schedule time of 14 minutes between East Portal, Mass., and North Adams, Mass. The locomotives for freight service were built to handle heavy freight trains having a maximum weight of 2,000 tons, including both steam and electric locomotives, and are required to accelerate this tonnage on the 0.5 per cent grade in the tunnel.

The under running gear consists of two massive trucks, Fig. 2. They are known as 2-4-0 articulated trucks and have 63 in. wheels. Each truck has two driving axles constituting a rigid wheel base of 7 ft., and a pilot axle arranged to swing radially on the well known Rushton truck principle. The truck side frames follow the general design of the cast steel frames for steam locomotives, except that they are outside of the wheels. These frames are joined at each end by a cast steel box section girder of sufficient strength to care for the stresses involved in bumping in freight service. The bumper girder at each end of the locomotive is equipped with an M. C. B. coupler mounted with a Westinghouse friction draft gear.

The adjacent bumper girders at the midlength of the locomotives are joined by a draw bar with a pin connection at each end. The eye in this bar is elongated at one end and the length of the bar is so arranged that it is impossible for the bar to be subjected to compression under severe bumping conditions. The three wheels on each side of each truck are equalized together. The longitudinal stability of the trucks is provided by the method of mounting the cab. The cab is supported by eight spring-loaded friction plates, two plates resting on each end of each truck. This relieves the truck center pins of all the weight. This method of supporting the cab interposes two sets of springs in series between the rail and the cab and gives an exceptionally easy riding cab. To relieve the cab from possible pulling and bumping strains, the center pin of one truck is arranged with longitudinal clearance. This truck can not only rotate but can also move longitudinally relative to the cab.



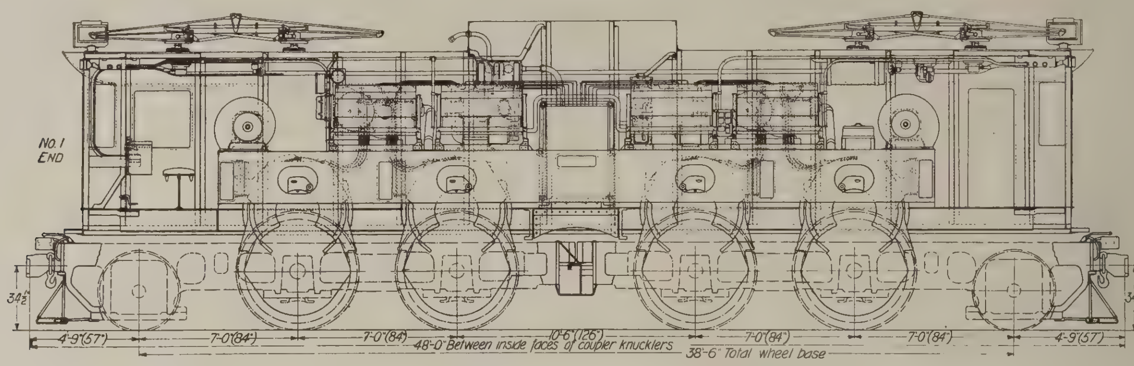
Running Gear and Motors of Hoosac Tunnel Locomotive.

In the interior of the cab a long raised deck is built along the center line which covers the motors and serves as a stand upon which the control apparatus is erected.

The central arrangement of the equipment, with the numerous side windows, affords excellent light and ample room for inspection and overhauling.

Each motor is bolted rigidly to cast steel cross ties,

and the weight of the motor is thus carried on the main semi-elliptic springs. The detail of this mounting is such that the motor can be lifted from the truck frame by a crane, after the cab has been removed, or the motor can be dropped into an overhauling pit when the trucks are in position under the cab. This method of mounting gives the highest center of gravity possible with a motor connected to the axle by single reduction gearing. It is particularly advantageous for locomotives that operate over tracks which are occasionally submerged.



Longitudinal Section of Locomotive.

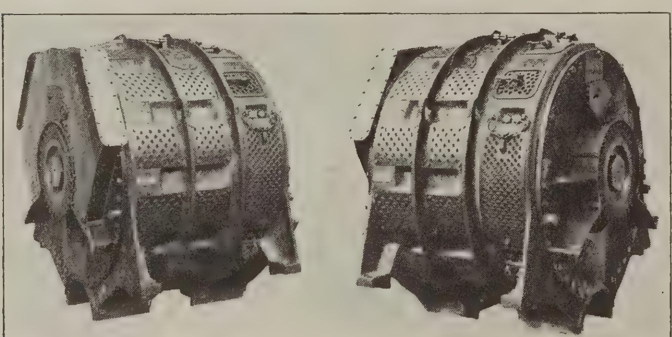
Each end of the motor armature shaft is fitted with a solid pinion (Fig. 4), which meshes with a gear having a rim that is flexibly connected to the center. The gear centers are mounted on opposite ends of a hollow axle or quill which surrounds the wheel axle with a 1½ in. radial clearance between the inner and outer axles. The gear center is equipped with six arms arranged alternately with the wheel spokes. The end of each arm is bolted to one end of a helical spring, and the other end is bolted to the wheel spoke. This spring is of sufficient flexibility to allow each wheel complete individual freedom in negotiating track inequalities. Fig. 5 shows a pair of driving wheels complete.

The total weight of each locomotive is 260,000 pounds, of which about 48,000 pounds is supported by each driving axle and about 34,000 pounds on each idle axle.

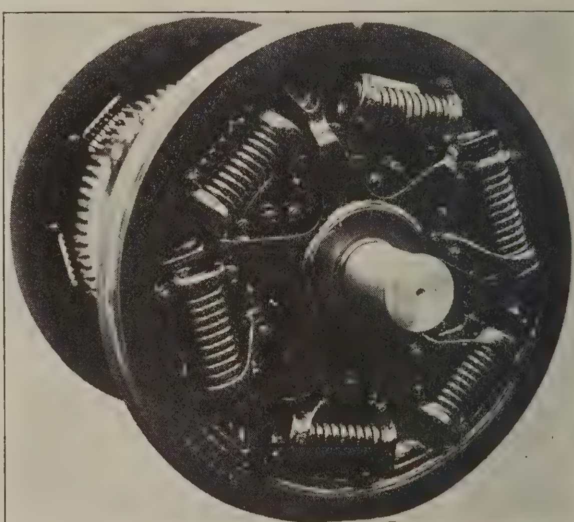
The gear ratio for the three freight locomotives is 22:91 and for the two combination freight and passenger locomotives is 34:79.

Each locomotive is equipped with four Westinghouse 315 h. p. air cooled, No. 403-A motors and with Westinghouse non-automatic unit switch control.

The freight locomotives have a continuous tractive effort of 21,000 pounds at 21 m. p. h. and the passenger locomotives have a continuous tractive effort of 9,500 pounds at 37 m. p. h.



Two Views of Motors, Showing Pinions at Each End.



Driving Wheels of Hoosac Tunnel Locomotive.

Design of Six Electric Locomotives for the Same Service

The Southern Railway of France decided sometime since to electrify an important section of its line to Spain. At the time this decision was made specifications of the requirements of an electric locomotive were drawn up and submitted to six different electrical manufacturers with the request that each design a locomotive to meet the requirements, which were as follows:

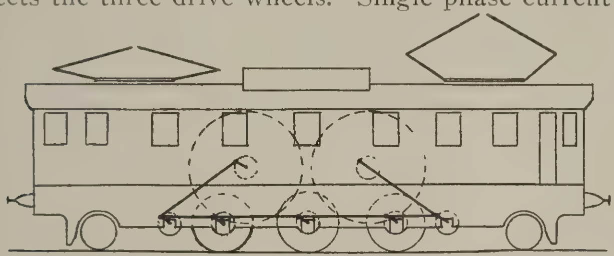
The locomotive must be able to start and haul a train of 440 tons over the line to be electrified. It must be able to haul a train of 200 tons at a speed of 25 miles per hour and a train of 110 tons at a speed of 38 miles per hour. On the down grade the motors must act as generators, returning power to the line. The temperature rise of the motors must not exceed 135 degrees at the end of a six hour run at normal load. The motors must be able to develop a power 25 per cent greater than normal for one hour without greater rise in temperature than that mentioned above. They must be able to withstand a temperature of 212 degrees without injury. The motor insulation must be able to withtsand for one minute the current cor-

responding to a tractive effort of 27,500 pounds at starting, 17,000 pounds at a speed of 28 miles per hour, and 9,200 pounds at a speed of 38 miles per hour.

Commutation must be satisfactory at all speeds. The total weight must be approximately 90 tons. The rigid wheel base must not exceed 13 feet.

Six companies designed locomotives to meet these requirements. The principal features of each have been reported by *La Technique Moderne* to be as follows:

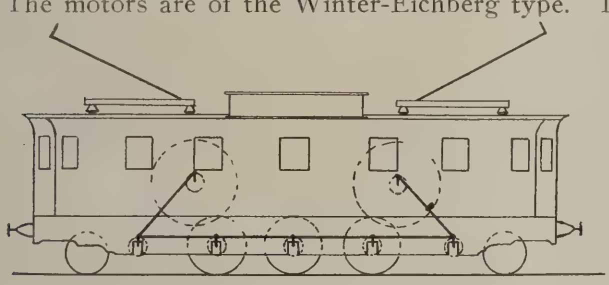
French General Electric Company: The motors are connected by rods to the ends of a shaft which connects the three drive wheels. Single phase current at



Locomotive Designed by French General Electric Co.

12,000 volts is taken from an overhead line by two pantograph trolleys, of which only one is ordinarily used. The two motors are connected in series to the secondary windings of the transformers so as to give a range of voltage from 80 to 370 volts. Each motor develops 600 horsepower but is able to deliver 750 horsepower for one hour. Speed variations are secured by varying the voltage across the field windings of the motors, which is done by connecting them to various points on the secondary winding of the transformer. When coasting down grade the traction motors act as generators, returning power to the line. The total wheel base is 31 feet and the driving wheel base, 13 feet. The total length is 45 feet, height above rail to top of cab, 14 feet, and total weight 98 tons.

French Electrical Association: Current at 12,000 volts is taken from an overhead line by two trolleys to the primary of a transformer which has two separate secondary windings—one for each of the two motors. The motors are of the Winter-Eichberg type. The



Locomotive Designed by French Electrical Association.

stator carries a special winding to give additional field strength at high speeds. On the collector are two sets of brushes, the first set supplying the field windings, the second set supplying to the rotor current from an auxiliary transformer. The primary of this auxiliary transformer is connected in series with the secondary of the main transformer.

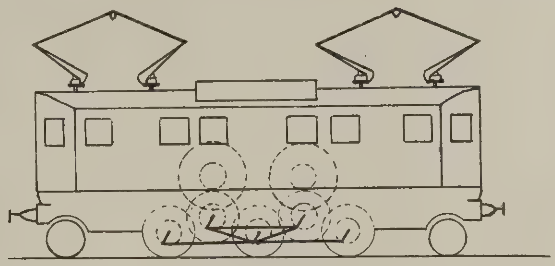
Different speeds are secured by varying the voltage across the motor terminals, the different voltages being taken from taps on the transformer secondary. Return of power to the line when running down grade is provided for by a special arrangement.

The total length of the locomotive is 43 feet. Height above rail, 13 ft. 9 in. Total wheel base, 31 ft. 6 in. Drive wheel base, 11 ft. 10 in. Total weight, 96 tons.

Westinghouse Company of France: The two motors are geared to auxiliary shafts which are connected by cranks to the drive wheels. Current at 12,000 volts is taken by a pantograph. The contact of this pantograph on the line is regulated by air cylinders.

Two stationary transformers are used. They are connected in parallel and their secondary windings have enough taps to give any voltage from 200 to 465 volts. The motors are of the series-compensated type operated in parallel. They are rated at 600 h. p. each.

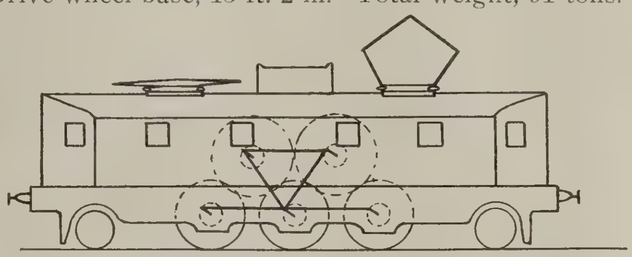
When coasting one of the motors is excited by current from the line and acts as a generator. Current



Locomotive Designed by Westinghouse Co. of France.

from this motor is used to excite the other, which returns power to the line.

The total length of the locomotive is 37 ft. 6 in. Height above rail, 12 ft. 7 in. Total wheel base, 29 ft. Drive wheel base, 13 ft. 2 in. Total weight, 91 tons.

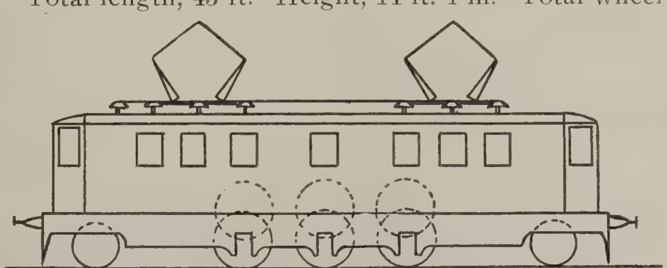


Locomotive Designed by Electro-Mechanic Co.

Electro-Mechanic Company: The two motors are connected together by a rod which is in turn connected by a double crank to the drive wheels. Current is taken from overhead by an air-controlled pantograph. Two transformers mounted in parallel reduce the voltage from 12,000 to 1,250 volts.

The motors are operated at this constant voltage. Starting, speed control and reversing of direction are accomplished by shifting the brushes. This is the only instance where this type of control is proposed.

Total length, 43 ft. Height, 14 ft. 4 in. Total wheel



Locomotive Designed by Northwest Electric Co.

base, 30 ft. 3 in. Drive wheel base, 12 ft. 6 in. Weight, 94 tons.

Northwest Electric Company: Three motors are provided, each being geared directly to the axle of a pair of drive wheels. The motors are of the series compensated type and are operated in series by the current from two transformers. The transformer primaries are connected in parallel, the secondaries are

connected in series. The motors are rated at 400 h. p. each. Speed regulation is accomplished by varying the voltage across the motor terminals from 200 to 760 volts. At speeds greater than 18 miles per hour the compensating winding is short circuited and the motors act as simple repulsion machines. The varying voltage is controlled by induction regulators on the transformers.

When coasting the traction motors serve as exciters for the motors which operate the air compressors, the latter returning power to the line. This would seem to be a rather injudicious arrangement as it is when coasting that these motors are likely to be needed to furnish air for braking.

Total length, 47 ft. Height, 12 ft. 6 in. Total wheel base, 33 ft. Drive wheel base, 12 ft. 6 in. Weight, 90 tons.

Schneider & Company: Each of the two motors is crank connected to an auxiliary shaft. These shafts are coupled to the drivers by connecting rods. A pantograph is used to collect the current. The transformer secondary winding is provided with taps to give from 150 to 500 volts.

The motors are of the series compensated type. Commutation is assured by an auxiliary field winding taking its current from an auxiliary transformer. When coasting one motor excites the other, which returns power to the line.

Total length, 46 ft. 6 in. Height, 12 ft. 6 in. Total wheel base, 32 ft. 3 in. Drive wheel base, 12 ft. 6 in. Weight, 92 tons.

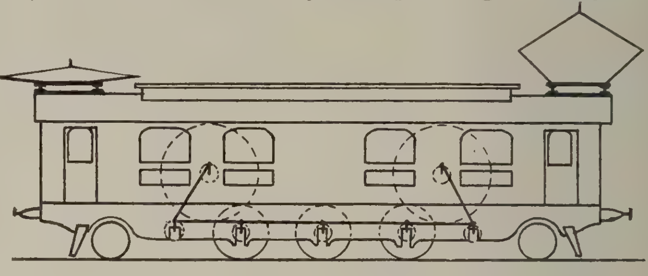
A comparison of these locomotives made in the accompanying table shows a considerable variation in several important points. The most striking difference, perhaps, is in the methods of transferring power from the motors to the axles. The most generally preferred way seems to be to drive through a connecting rod pinned to the drive wheels and connected at its ends to the motors by cranks.

Only one designer has attempted to use direct gearing of the type which is standard for driving street railway cars. By so doing he seems to have slightly reduced the weight, this locomotive (Northwest Electric Co.) being the lightest of the six. Apparently direct gearing is not generally considered well adapted for the heavier loads and higher speeds of trunk line service.

Speed control by varying the field voltage is used in all but one of the proposed designs. The exception is that of the Electro-Mechanic Co., which proposes to control the motors entirely by varying the brush position. This method possesses one advantage—simplicity. It greatly lowers the efficiency of the motors and at 1,250 volts would seem to be dangerous.

The pantograph current collector is used in all but one of the designs, and would seem to be essential to service of this sort, where the overhead line carries 12,000 volts.

For returning power to the line one motor is usually made to act as an exciter for the other, both acting as generators and the second returning power to the line, or as the French say, recuperating. Except in mountain districts with steep grades, this provision is of small account. Certainly it is not important on the railroad in question.



Locomotive Designed by Schneider & Co.

COMPARISON OF SIX ELECTRIC LOCOMOTIVES DESIGNED FOR THE SAME SERVICE

Item	General Electric.	French Elec. Association.	Westinghouse	Electro-Mechanic	Northwest	Schneider
Total Length.	45.2 ft.	44.2 ft.	37.5 ft.	43.2 ft.	47.0 ft.	46.6 ft.
Total Height.	13.7 "	13.7 "	12.5 "	14.3 "	12.5 "	12.5 "
Total Weight.	98.5 t.	96.3 t.	90.7 t.	94.0 t.	89.6 t.	91.8 t.
No.Motors.	2	2	2	2	3	2
Type of Motors.	Ser.-Rep.	Winter-Eich.	Ser.-Compen.	--------	Ser.-Comp.	Ser.-Comp
Speed Control.	Voltage	Voltage	Voltage	Brush	Voltage	Voltage
Voltage Range.	80-370	----------	200-465	- 1250 -	200-760	150-500
No.Drive Wheels.	6	6	6	6	6	6
Diam. " "	2'10"	2'10"	2'10"	2'10"	3'3"	2'10"
Method of Drive.	Aux.Shaft	Connect.Rod.	Geared Shaft	Con. Rod.	Gearing	Aux.Shaft
Drive Wheel Base.	12'10"	11'10"	13' 2"	12' 6"	12' 6"	12' 6"
Total Wheel Base.	31' 4"	31' 4"	29' 0"	30' 3"	33' 0"	32' 3"

SWISS AUTHORITIES ADOPT SINGLE PHASE SYSTEM FOR STATE RAILROAD

In the Daily Consular and Trade Reports of August 28, 1911, the following statement in regard to the electrification of the Swiss State Railways appears:

"I am able to state on the highest possible authority that the report of the Swiss Commission which has been investigating the question of the electrification of the Swiss national railways will recommend the adoption of the overhead system similar to that which is now in use upon the London Bridge, Victoria & Crystal Palace Lines of the London, Brighton & South Coast Railway. This decision has been arrived at after a most careful comparison with the third-rail system as adopted upon the underground railways of London and other electric railways in this country.

The importance of electric railway working was fully recognized by the Swiss State authorities as far back as 1904, when a commission of 22 experts was appointed to study the matter. Up to the present time three reports have been issued by this commission; the first deals with the probable power requirements of the whole Federal system, consisting of 1830 miles; the second concerns the nature of the traffic, and the third deals with the most suitable system; that is, continuous current or alternating current. The report about to be issued will recommend the adoption of a single-phase, alternating current system with a pressure of 15,000 volts in the overhead wires. The first work to be taken in hand will be the conversion of the St. Gothard Railway, and comparative estimates have shown that the adoption of the third-rail continuous current system, so much in use in London, would involve a capital expenditure of about 8 per cent more than with the overhead system.

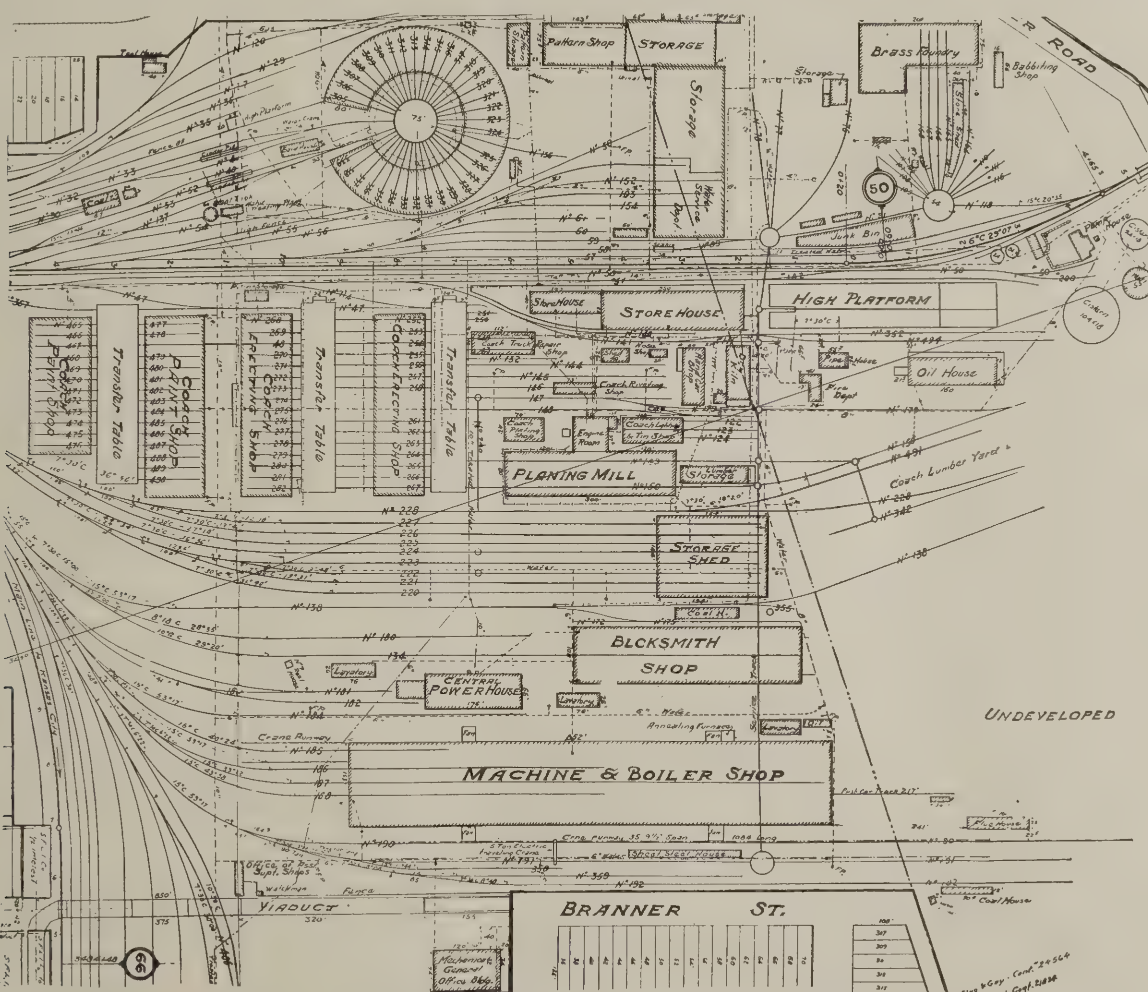
SHOP SECTION

EDITED BY GEO. W. CRAVENS

Shop Series 6—A. T. & S. F. Ry.

The principal shops of the Santa Fe system, are located in Topeka, Kan. They cover a large, but very irregular, piece of land and lie between the main line tracks and the Kansas river. The locomotive and passenger car shops form one, and the larger group, and the freight car shops form the other. The latter shops are several blocks east of the others, and parallel to the main line tracks.

The general arrangement of these shops can be seen



Layout of Santa Fe Shops at Topeka. Kansas.

by the reference to the plan herewith, and it will be noted that the unusual practice of placing the passenger car shops in the center of the group has been followed. The round house is placed at the opposite side of the grounds from the locomotive shops, although the arrangement of the various departments of each group with reference to the storage sheds is logical. The central plant is also near the center of gravity of the load.

Power Plant, and Distribution System.

The central power house lies near the machine and boiler shops, and is 56 ft. wide by 176 ft. long. A feature of this plant is the use of crude oil for fuel, this being burned under the eight locomotive type 200 h. p. boilers and generating steam at 150 lbs. gauge pressure. There are also installed one Coles 1,600 h. p. feed water heater, two Fairbanks-Morse 10 in. by 6 in. by 12 in. feed water pumps, two Morse 8 in. by 12 in. by 12 in. vacuum pumps, and one Worthington 20 in. by 4½ in. by 10 in. hydraulic duplex pump. There is also a hydraulic accumulator delivering water at 1,500 lbs. pressure to the flanging and riveting shops.

The engine room contains three General Electric 200 k. w. 250 volt d. c. generators direct connected to three Ball tandem compound 325 h. p. engines running at 200 r. p. m. and one General Electric 75 k. w. 250 volt d. c. generator direct coupled to a 120 h. p. Ball tandem compound engine running at 270 r. p. m. There is also a Rand duplex air compressor 2,300 ft. capacity and a Laidlaw-Drum-Gordon duplex compressor of 1,600 ft. capacity, both supplying air at 100 lbs. pressure for pneumatic tools about the shops. A 7½ ton Whiting hand operated crane of 51 ft. 10 in. span is installed here for handling the heavy parts of apparatus.

The switchboard consists of 11 marble panels, each 7 ft. high, and is 32 ft. long. Of these panels, four are equipped to control the generators, two for lights, two for power, two with gauges, and 1 with meters. The lighting circuits are of 1300 and 600 amp. capacity respectively, and the power circuits of 3,200 and 800 amps. capacity.

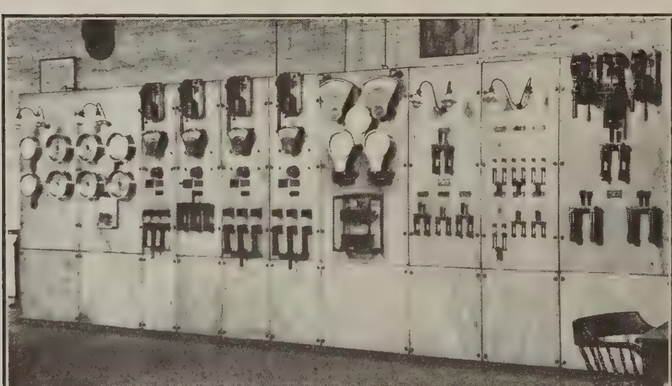
Practically all this electric power is used in the locomotive shop, which directly adjoins the power house. It is transmitted through underground cables, connecting the two buildings. Overhead transmission lines of small capacity carried on wooden poles supply the lighting circuits in other buildings.

General View of Shops, Locomotive Shop in Foreground.

In addition to this power plant there are two smaller ones burning wood scrap and running the planing mill machinery.

Locomotive Shop.

This shop is the largest building of the main group, being 852 ft. long by 153 ft. wide, and consists of a central bay two stories high, and two side bays each one story high. The lighting of this building is especially good because of the large skylights, those on the bays being of saw tooth construction. The middle section, 74 ft. wide, is used for erecting, and is equipped with two Whiting, 60-ton, 4-motor travelling cranes of 69 ft. 6 in. span with a 5-ton auxiliary hoist and one 30-ton crane of the same type and span. In the west bay are two 3-motor cranes of five tons capacity, and two of 10 tons, all of 35 ft. 9½ in. span.



Switchboard in the Central Power Plant.

In this building are the erecting and repair departments, boiler shops, machine shop, sheet metal department, tender repair, flue shop, brass department, screw department, air brakes, tin shop and tool manufacturing department. All machinery in this building is motor driven, either directly, or in groups. The craneway in the west bay is continued 200 ft. beyond the south end of the building, to handle driving wheels. In the east bay there is a balcony 525 ft. long, accommodating several of the smaller departments, and the tool makers.

The hydraulic riveting plant here contains a 150-ton riveter with 19 ft. throat, served by a 25-ton crane, and a 100-ton riveter with 12 ft. 6 in. throat, served by a 10-ton crane. Numerous large machine tools are installed here, a complete list being given in Table I.

Freight Car Shops.

The freight car repair plant is entirely separate from the other shops and has just recently been put in commission. It is provided with its own steam power plant, the boilers being fired largely with wood scrap from the planing mill. It contains practically no elec-

TABLE I.- MOTOR DRIVES IN LOCOMOTIVE SHOP.

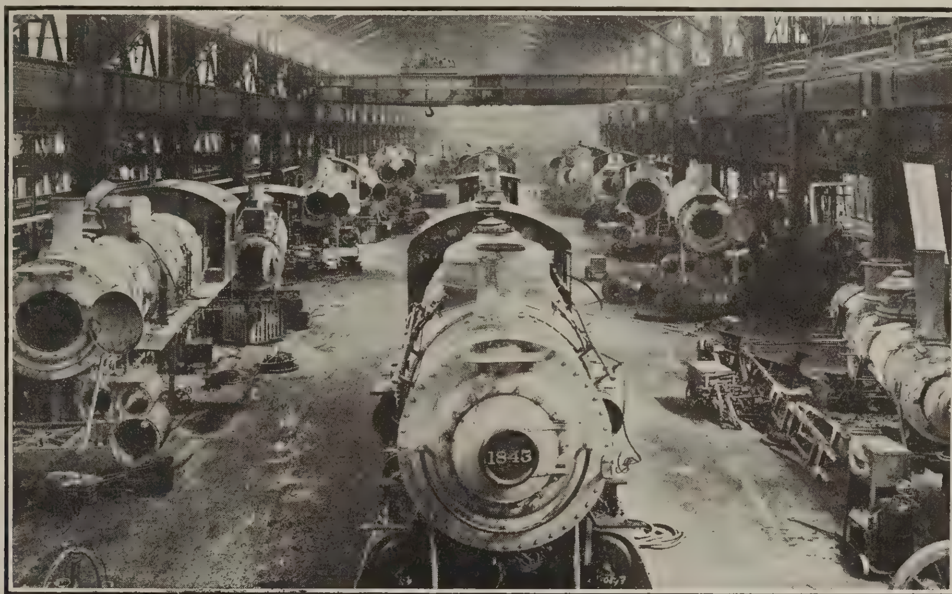
No.	Machine	Size	Motor H.P.	Motor R.P.M.
1	Single Head Slotter	24" Stroke	5	1000
1	Radial Drill Press	60"	5	1250
1	Double Head Slotter	22" Stroke	10	600-900
1	Planer	27' x 51"	20	700
1	Bushing Lathe	32" x 17"	15	550-1100
1	Engine Lathe	29" x 17"	10	600-1200
1	Vertical Boring Mill	51"	15	800
1	Radial Drill Press		3	550-1100
2	Tool Grinders	2" x 20"	3	1250
1	Cylinder Borer	38"	15	400-800
1	Planer	18' x 86"	25	850
1	Vertical Boring Mill	101" swing	25	560-1120
1	" " "	72" "	7	815
1	Drive Wheel Lathe	90"	30	515-1030
1	" " "	82"	7	815
1	" " "	72"	7	815
1	Axle Lathe		10	350-700
1	Boring Mill		3	80011600
2	Boring Mills		20	670
1	Portable Cyl.Borer		5	1100
2	Groups of Tools		7	815
1	" " "		15	800
1	" " "		20	670
1	" " "		25	625
2	Elevators		7	815
	----Brass and Tin Shop-----			
1	Group of Tools		5	1100
1	" " "		7	815
1	" " "		15	765
1	" " "		25	625

------ Boiler Shop --------

Machine	Motor H.P.	Motor R.P.M.	Machine	Motor H.P.	Motor R.P.M.
Gang Drill	5	1080	Splitt.Shear	7	815
Radial Drill	2	1200	Punch-Shear	5	800
Bolt Machine	7	815	Plave Roll	10	650
Plate Planer	10	650	Shear	7	815
Bevel Shear	7	815	Punch	3	1100
Angle Iron Roll	10	585	Shear	5	1100
Flue Cutter	7	815	Riveter	7	615
Flue Rattler	15	600	Blower	15	925
" "	20	670	Group Drive	15	800
Rip Saw	2	1650			
-----Blacksmith Shop -------					
Punch & Shear	20	630	Group Drive	40	
Blower	25	875	2-Group Drives	50	

trically driven machinery, power transmission being effected by overhead shafting belted to the tools. This is rather surprising in a recently built plant.

The main building 208 by 900 ft. in size contains 12 tracks running through its entire length. It is one story in height and built with a saw tooth roof which



Locomotive Erecting Shop.

gives excellent daylight lighting. At various places through this building have been placed six motor driven saws, one motor driven pipe cutter, nut and bolt racks, air hose connections, and numerous pneumatic and other small tools.

A structural steel shop for heavy repairs to steel underframes is located in a building 80 ft. by 200 ft. nearby. The equipment consists of the usual assortment of punches, shears, riveters, forges, hammers, etc., and power is supplied by steam from the mill boiler room.

The planing mill is in a building 76 ft. by 352 ft. located at the west of the car repair shop, and an annex 50 ft. by 80 ft. contains the boiler and engine rooms. Further reference will be made to this mill later. A large material shed, a dry kiln and a wheel shop comprise the balance of this group of buildings.

Passenger Car Shops.

Five large buildings, with several small ones, are used for passenger car building, repairing and painting, and they form one compact group. The two coach erecting shops are each 90 ft. by 340 ft. and the two coach paint shops are respectively 110 ft. by 340 ft. and 110 ft. by 240 ft. Three transfer tables serve these buildings and tracks run through each building. A part of one of the erecting shops is two stories high, the second floor containing the upholstering room, all other buildings being one story high.

One of the Bays in the Locomotive Shop.

The small buildings include a hand car shop, hose shed, carpenter shed, coach truck shop, riveting shop, coach plating shop, coach lighting and tin shops. The planing mill will be described later under the proper heading. A boiler and engine are located by this mill also for furnishing steam from wood scrap. All electric wiring in these buildings is in conduits and 16

c. p. drop lights are very generally used. A few arc lamps are also provided for general illumination. Pits extend along most of the tracks in the four coach buildings, and electric motors are used to operate transfers. These shops can repair 90 cars per week.

Blacksmith Shop and Foundry.

The smith shop is 100 ft. by 400 ft. and is fully equipped for heavy railroad repairs and spring making. Most of the machines are group driven where motors are used. There are 21 oil burning furnaces here, five of which also heat boilers to make steam for the hammers. There are 16 hammers of from 150 lbs. to 5,000 lbs., 38 forges, 15 hand cranes, 8 bolt headers and 26 other machines in this shop.

The foundry is located near the river in the northwest corner of the grounds and is approximately 100 ft. by 200 ft. in size. All of the brass castings for the Santa Fe are made here by the Hewitt Mfg. Co., which has leased the plant and furnishes castings under contract. A power plant is located here for driving the machinery. The equipment includes crucible coke furnaces, oil burning furnaces, rattlers, and flasks for large output.

The pattern shop is near the foundry and is 75 ft. by 143 ft. one story high. A 20 h. p. motor drives all of the tools as one group, there being about a dozen of these. The pattern storage building is 40 ft. by 75 ft. and four stories high. The water service or miscellaneous repair department occupies a part of the storage building near the pattern shop. Here is where all machinery, steam shovels, motor cars, etc., are repaired, and the tools here are also group driven by a 20 h. p. motor.

Planing Mills.

There are two wood working shops at Topeka, one at the freight car shops and the other at the passenger car shops. The freight planing mill is one story high and 76 ft. by 352 ft., and fitted with four line shafts driven by a Corliss engine. There are four 150 h. p. return tubular boilers, one 600 h. p. feed water heater, two boiler feed pumps, and two vacuum pumps in the annex. Besides the engine there is a 2,000 cu. ft. air compressor and two 40 k. w. alternating current generators in the engine room.

Wood scrap is used exclusively for fuel here. A dry kiln 50 ft. by 62 ft. is located just west of this planing mill with a track through each of its seven cells.

The planing mill at the passenger car department is a two-story building 80 ft. by 300 ft., with a 60 ft. by 60 ft. power house annex. There are three 125 h. p. return tubular boilers here, also feed water pumps, feed water heater, vacuum pumps and a Corliss engine for driving the mill. This engine was the first prime mover installed and has been in service since 1883. Wood scrap from the mill is used as fuel here also. This building contains the wheel shop, planing mill, cab and pilot shops.

The coach wheel shop contains the following tools:

2 43-in. car wheel lathes.	2 drill presses.
1 car wheel press.	1 power punch.
1 axle lathe.	1 engine lathe.
1 axle cutting off lathe.	1 speed lathe.
1 car wheel borer.	3 grinders.
1 bolt cutter.	

The coach planing mill contains 35 miscellaneous woodworking machines, seven miscellaneous grinders and sharpeners, and two 60 in. shavings exhaust fans.

New Freight Car Repair Shop.

A dry kiln 44 ft. by 96 ft. is located near by for coach lumber.

Round House and Stores.

Located at the west edge of the grounds is the round house. This is 80 ft. in width and contains 36 stalls. The 75 ft. turntable is driven by an electric motor. There are a gravity coal chute, cinder pits and sand house here also.

Numerous store houses are located about the grounds, the largest being 144 ft. by 164 ft. and placed between the smith shop and planing mill. This is a shed with open sides. The principal store rooms are in the building near the pattern shop. These are two stories high, one being 68 ft. by 250 ft. and the other 40 ft. by 125 ft. A platform 78 ft. by 400 ft. is located just north of these store houses for castings and locomotive parts. The oil house is of reinforced concrete 50 ft. by 160 ft. and is the most completely equipped building of its kind in existence. It is located near the north edge of the grounds.

Motor-Driven 22-Inch Locomotive Frame Slotter.

Miscellaneous.

A new general office building has lately been erected. It is a four-story reinforced concrete structure with red brick outside walls, 75 ft. by 120 ft. in size and thoroughly fireproof. Excellent artificial lighting by large and small tungsten lamps under Alba shades is provided.

Much has been written about the "scientific management" of these shops. The bonus system of paying operators has given excellent results in way of increased output. Each bunch of men is organized into a team and these teams compete with each other for the efficiency championship. The standing of the teams is posted on a large blackboard in the locomo-

tive shop, which is an object of great interest to every employe when the monthly report comes out.

These shops are not a good example of advanced practice in electrical equipment. Apparently the Santa Fe authorities are not great believers in the advantages of electric drive, as the new freight car shop tools are nearly all line shaft driven.

The artificial lighting is rather inadequate. Probably the shops are not operated much at night. Small incandescent lamps on drop cords are mostly used. No large tungsten units and very few reflectors are to be seen.

Excellent provision is made for handling car lighting equipment. A large room is devoted to storage battery treatment and a small shop with the necessary tools facilitates repairs to axle lighting equipment. The Santa Fe uses axle electric car lighting systems extensively.

The writer is indebted to Mr. F. R. Frost, electrical engineer, and Mr. F. H. Adams, engineer of shop extension, for much of the material included in this article, and to the *Santa Fe Employes' Magazine* for several illustrations.

DISTRIBUTION OF ELECTRIC POWER

Department	Lighting			Motors					
	Incandescent	Arc	Mercury Vapor	Machine		Crane		Transfer	
				No.	H.P.	No.	H.P.	No.	H.P.
Machine and Boiler Shop.	500	42	4	49	530	17	313		
Blacksmith Shop.	20	10		5	185				
Woodworking Mill.	150								
Passenger Car Shop.	230			4	85			2	50
Paint Shop.	250							1	15
Freight Car Shop.	680	8		4	60				
Pattern Shop.	200			1	20				
Foundry.	30	12		2	40				
Stores.	300			1	7½				
Roundhouse.	180			2	12½				
Office Building.	980			1	20				
Yards	70	60				6	24		
Power House	40	4		1	5				
TOTAL	3630	136	4	70	965	23	337	3	65

UNDERCUTTING COMMUTATOR MICA AND REMOVING BAD SPOTS.

By Gordon Fox.

The commutator is the cause of more than 75 per cent of the troubles with direct-current motors. The most usual complaint is excessive sparking, resulting in rapid brush wear and blackening and heating of the commutator, possibly causing the solder in the risers to melt and become dislodged.

It is impossible to obtain satisfactory commutation on some motors. Often the sparking is just sufficient to pit the copper, cause high mica and start the commutator on its downward way. When it is impossible to prevent all sparking, even with the motor in good condition, it is often possible to reduce its destructive effect by slightly undercutting the mica. Various methods have been used for doing this. An excellent method is to "plane" the mica off with a 6-inch three-cornered file; one with considerable belly and a decided taper toward the end is preferable. This is broken off about an inch from the end and the new end is ground square on an emery wheel, care being taken not to mark the sides. The commutator is first trued up and smoothed by turning or sandpapering; the mica is then cut down by starting the belly of the file at the outer end of the commutator and working toward the risers, using the groundoff end of the file as a sort of plow. The belly of the file follows in the groove cut and keeps the tool on the mica. A little practice will enable one to undercut the mica of a commutator by this means in a surprisingly short time. The groove is not deep like that cut by a hack saw and is not as troublesome in the way of collecting dirt. After the mica is undercut the commutator is again smoothed and cleaned. The writer has used this means to cure rough commutators very often and has found it an excellent expedient.

Commutators often give trouble due to excessive heating, short-circuits between the bars and grounds. In many instances such troubles are due to deterioration of the mica by oil. There is often a leakage of oil along the shaft from the bearings and the oil creeps up onto the commutator, soaks into the mica and destroys its insulating qualities. The current then leaks through from bar to bar and causes excessive heating and possibly short-circuits. Sometimes the mica rings break down, producing a ground. Special care should be exercised to keep the commutator free from oil. Where there is leakage a leather washer, held against the inner end of the bearing housing by a sheet-iron washer of slightly larger inside diameter fastened to the housing with screws, will prevent suction of oil and keep it from creeping along the shaft from the bearing.

When it is found that the mica segments have been rotted in spots, all blackened mica should be scraped or dug out with a broken hack-saw blade with the set of the teeth ground off. The void should be filled with a paste consisting of powdered mica (two parts), plaster of paris (one part) and enough shellac to make a thick paste. The copper around the patch is then heated slightly with a torch and the paste allowed to harden. This will require but a short time. The surface of the commutator is then smoothed over and the machine is ready to run. If properly applied, a patch of this kind will not come out.

The keynote to success in caring for direct-current motors is to anticipate trouble and take proper steps to prevent it before the commutators begin to deteriorate. After they once start to cutting or roughing they get worse and worse so rapidly that it is almost impossible to stop it except by turning down.—*Power.*

Recent Patents

OF INTEREST TO THE RAILWAY ELECTRICAL ENGINEER

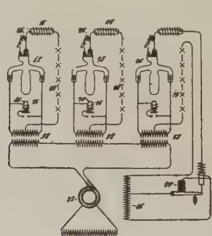
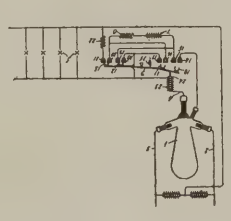
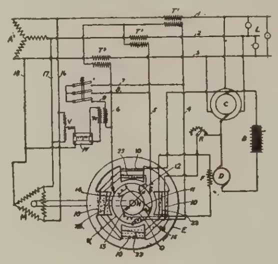
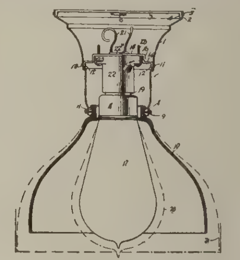
Note: Patent No. 1,000,000 was issued on Aug. 8, 1911, to Mr. F. H. Holton, of Akron, Ohio. This is the millionth patent issued since July 28, 1836, prior to which time 9,957 patents were issued. The patent office now has a surplus of $7,000,000, an average profit of $7 per patent issued out of an average receipt of about $55. About 57 patents are granted out of every 100 applications filed. The present rate of issue is about 750 per week.

996,676. STORAGE BATTERY.

Grant I. Rawson and Llewellyn B. Shultz, assignors to Pilley Mfg. Co., St. Louis, Mo. A block of insulating material forms a cap for the battery containing jar and a filling of plastic material secures this cap to the container.

996,848. VAPOR-RECTIFIER.

Chas. M. Green, assignor to General Electric Co. The consumption circuit receives continuous current which operates an automatic device controlling the voltage impressed across the alternating current terminals of the rectifier. Substantially constant continuous current is thus maintained in the consumption circuit.

996,848.—Vapor-Rectifier. 996,975.—Rectifier System. 999,690.—Distribution System. 999,998.—Electric Lamp Fixture.

996,975. RECTIFIER SYSTEM.

Alexander Churchward, assignor to General Electric Co. Stability of operation is maintained by connecting a storage battery into the secondary circuit when the load in that circuit decreases below a predetermined value and disconnecting the battery when normal conditions are restored.

997,984. ELECTRIC STORAGE BATTERY.

Bruce Ford, Philadelphia, Pa. Finely divided graphite is mixed with a solution of tannin and thus introduced into the pores of the negative plates of a lead storage battery. The tannin is afterward neutralized.

998,223. ELECTRIC MERCURY VAPOR LAMP.

John M. Anck, Philadelphia, Pa. The luminous arc of mercury vapor is formed in a bent tube by rotating the tube. Normally the middle point of the tube is its highest point.

999,690. SYSTEM OF ELECTRICAL DISTRIBUTION.

J. L. Woodbridge, Philadelphia, Pa. The storage battery current is controlled by the current in a field coil, which is in turn controlled by the potential in the storage battery circuit. When the battery current is normal the effect of the regulating potential is neutralized.

999,754. ELECTRIC RAILWAY.

Richard J. Dearborn, assignor to Westinghouse Elec. & Mfg. Co. A pantograph trolley takes current from two parallel overhead wires of a three-phase circuit.

999,762. STORAGE BATTERY AND PROCESS FOR TREATING

Thos. A. Edison, assignor to Edison Storage Battery Co. An active material for the negative electrode of a storage battery, comprising finely divided iron and bismuth. The process consists of soaking the active material in a solution of bismuth tri-chlorid in acetone.

999,998. ELECTRIC LAMP FIXTURE.

William C. Hine, Conneaut, Ohio. A combined lamp and shade holder, the lamp socket being adapted to various sizes of incandescent lamps and its position relative to the shade changeable by reversing the position of its support.

1,000,330. STORAGE BATTERY SEPARATOR.

Norman Dodge, assignor to Electric Storage Battery Co. A wood separator for storage battery plates from which have been removed all elements injurious to the battery.

1,000,542. COMBINED LAMP AND SHADE HOLDER.

James Stoddart, assignor to The Enos Co., New York City. The lamp socket is adjustable relative to the shade holder by means of a tube which extends through a bore in the upper part of the fixture.

1,000,831. APPARATUS FOR MEASURING LIGHT.

J. F. Martin, Pittsburg, Pa. The torque value of the light as measured by a radiometer is made to move a pointer on a scale giving light values direct.

1,001,358. TRAIN-LIGHTING SYSTEM.

John Peachey Crouch, Newton Heath, and James Etchells, Moston, Manchester, England. Filed Nov. 27, 1909. Comprises a reversible dynamo, a battery, and a consumption circuit alternatively supplied from such dynamo and battery, a main switch corresponding to each direction of rotation of the dynamo having series and shunt operating windings, and means responsive to reversal of rotation of the dynamo for bringing one shunt winding into circuit for one direction of rotation of the dynamo and the other for the opposite direction of rotation.

1,001,647. SPEED REGULATOR FOR ELECTRIC MOTORS.

Julius T. Kalweit and William H. Gaulke, Milwaukee, Wis., assignor to Independent Electric Manufacturing Co. Filed Oct. 20, 1910. Combines a contact-arm, means for resiliently moving it into the starting position, an electromagnet, a sliding bar guided to reciprocate in an endwise direction and having a plurality of notches on its upper side, an intermediate member connecting the bar with the arm, and a toothed member with which the notches are adapted to engage in the respective positions of the arm; the electromagnet being operatively connected with the arm and adapted when energized to hold the member in engagement with the notches.

1,002,713. SELECTIVE SIGNALING SYSTEM.

Oscar M. Leich, Chicago, Ill., assignor of one-third to J. G. Ihmsen and two-thirds to P. C. Burns, Chicago, Ill. Filed May 3, 1901. Alternating current of different frequencies is impressed on the line operating signal devices responsive to these frequencies. Each station circuit is non-tuned or non-resonant for the particular frequency by which its allotted signal-receiving device is operated.

1,003,250. SELECTIVE SIGNALING SYSTEM.

Edwin R. Gill, Yonkers, N. Y., assignor to Howard E. Merrell, New York, N. Y., and Orlo J. Hamlin, Smethport, Pa. Filed Sept. 4, 1908. Renewed Dec. 13, 1910. Comprises a selective signaling instrument, a local signal circuit, an answer back circuit, a momentary circuit closer in the answer-back circuit, a permanent circuit closer in the local signal circuit, and a common motive means for the two circuit closers controlled by the selective signaling instrument.

1,003,829. ELECTRICAL SYSTEM OF DISTRIBUTION.

Edward Van Wagenen, New York, N. Y., assignor to Gould Storage Battery Co. Filed July 12, 1909. A booster is connected in series with the battery, an exciter supplying current to the field windings. Field windings on the exciter are subject to variations of load on the circuit, other windings being connected across the booster armature and arranged to cut down the flux, produced by the first field windings both when the battery charges and when it discharges.

1,003,746. ELECTRICAL SYSTEM OF DISTRIBUTION.

Albert S. Hubbard, Belleville, N. J., assignor to Gould Storage Battery Co. Filed Jan. 28, 1909. An induction motor drives a direct-current generator, which supplies current to the lines and also to a local storage battery. Means are provided for varying the division of load between the battery and the generator, these means being responsive to load fluctuations on the motor.

1,003,747. ELECTRICAL SYSTEM OF DISTRIBUTION.

Albert S. Hubbard, Belleville, N. J., assignor to Gould Storage Battery Co. Filed Dec. 10, 1909. Renewed July 8, 1911. Combines a main circuit, a battery connected across the circuit, a booster in series with the battery, an exciter in series with the booster field, a field coil for the exciter subject to variations in the electrical condition of the system and an opposing field coil for the exciter connected in series with the booster field.

1,003,882. ELECTRIC REGULATOR.

Stuart Y. Culley, Covington, Ky. Filed Dec. 23, 1910. A reservoir containing mercury is moved up and down by the action of a solenoid. A stationary box immersed in the mercury is provided with a hole for admitting and releasing mercury. This box contains a series of contact fingers connected at their upper ends by resistances and dipping successively farther and farther into the mercury as the solenoid core rises.

1,004,005. TRAIN AND LIKE ELECTRIC-LIGHTING SYSTEM.

Thomas Ferguson, Altrincham, England, assignor to himself and Leeds Forge Co., Ltd., Leeds, England. Filed Oct. 21, 1910. An axle car-lighting system includes a generator, a storage battery and a voltage-compensating regulator with automatic switches and compensating resistances.

1,004,379. ELECTRIC REGULATION.

John L. Creveling, New York, N. Y., assignor to Safety Car Heating & Lighting Co. Filed April 13, 1911. Combines means for controlling the regulating means responsive to current fluctuations, means for affecting the regulating means responsive to voltage fluctuations, a translation circuit, a translation-circuit regulator and means whereby the degree of operation of the translation-circuit regulator affects the voltage-responsive means.

General News and Personal Mention

FREIGHT TONNAGE IN THE UNITED STATES.

The Santa Fe Railroad Co. has prepared an excerpt from the report of the Interstate Commerce Commission for the year ended June 30, 1909, showing the classification in tons of all railroad freight traffic in the United States. It is somewhat astonishing to discover that mine products constitute more than one-half of the total tonnage of the country, or 55.6 per cent of the whole, including manufactures and all farm products. The figures, with the percentage of each, are as follows:

	Tons.	Pct. of Total
Grain	34,111,231	4.1
Fruit and vegetables	9,762,769	1.1
Grain products	12,954,902	1.6
Hay	5,453,515	0.6
Sugar	2,499,122	0.3
Tobacco	794,433	0.1
Other vegetable matter	6,656,396	0.8
Total farm products	96,776,194	11.7
Mine products	459,560,732	55.6
Forest products	97,104,700	11.7
Manufactures	106,178,007	12.9
All other including freight in less than carload lots	66,873,132	8.1
Total	826,492,765	100.0
Animals, live	11,699,070	1.0
Animal products	8,894,282	1.1
Cotton	3,950,479	0.6

BUCKEYE ENGINEERS MEET LONG FELT WANT.

The Buckeye Electric Company has recently called the attention of lamp buyers to some "Consequences." After citing some of those given by Sam Bernard in "He Came From Milwaukee" their letter goes on to say that

The Buckeye Electric Engineering Department
Met a "Long Felt Want."

The Buckeye Electric Engineering Department said "What can I do to get rid of you?"

The L. F. W. said—"The old pressed filament was composed of four or five loops in series, in the latter case one loop apt to operate at a higher temperature than the others, with a consequent shortening of life. Make a one-piece filament."

CONSEQUENCES—The Buckeye drawn wire Mazda filament now built in one piece.

The Cooper Hewitt Electric Company has recently installed a large number of mercury vapor lamps in the Chicago shops of the Chicago & Northwestern Railway. The installation was made by Geo. Keech, Chicago representative.

The Burke Electric Company, Erie, Pa., has recently developed a line of extra-heavy mill type motors. These motors are designed to carry very heavy momentary overloads and meet the requirements of the most severe service.

IMPROVED BALL BEARING JOURNAL JACK.

The Duff Manufacturing Company, Pittsburg, Pa., has recently placed on the market an improved ball bearing journal jack. This jack is specially designed for use in passenger car yards where cars must be jacked up for repairs to journals or installation of axle lighting equipment. An adjustable wheel holding device designed to hold down the wheel when operating

Improved Ball Bearing Journal Jack.

is one of the improvements embodied in this jack. A positive stop prevents raising the lifting bar out of the jack. The load is raised only on the downward movement of the lever.

U. S. COMPANY GETS BIG ORDERS.

The United States Light & Heating Company reports the receipt of several large orders for electric car lighting equipments. Among these are 100 cars for the New York, New Haven & Hartford R. R., 46 cars for the New York Central, 52 for the St. Louis & San Francisco, and 42 for the Lehigh Valley. This company extends to all those interested an invitation to visit its factory at Niagara Falls. The factory is now turning out its full capacity of production all the time.

GENERAL ELECTRIC BULLETINS.

The following bulletins of interest to railway men have recently been issued by the General Electric Company: No. 4819, A. C. Switchboard Panels; No. 4825, Switchboard Instruments; No. 4852, 50-Ton Electric Locomotives; No. 4829, Electric Locomotives for Industrial Railways.

The Hoskins Mfg. Company, of Detroit, Mich., has taken over the business of the International Electric Meter Company, of Chicago. The new management will continue the manufacture of the same line of instruments.

The Adams-Bagnall Electric Co., Cleveland, Ohio, have recently issued their Catalog 100 descriptive of the A-B regenerative flame arc lamp. This lamp is especially adapted to lighting railway yards and terminals on account of its high efficiency, the peculiarly penetrating quality of its light, and the infrequent trimming required. Another folder of this company describes the various types and sizes of ABolites.

Cost of Operating Electric Lighted Cars of the Chicago & Alton R. R. July, 1910, to May, 1911, Inclusive

Station. Item.	Jul. '10	Aug. '10	Sep. '10	Oct. '10	Nov. '10	Dec. '10	Jan. '11	Feb. '11	Mar. '11	Apr. '11	May '11	Total Material	Total Current	Total Labor	Average for Whole time
Brighton Park—															
Material .....$	420.21	$ 299.52	$ 281.32	$ 346.03	$ 282.53	$ 355.31	$ 332.94	$ 347.56	$ 341.04	$ 322.01	$ 680.36**	$4,008.84			$ 364.44
Current at 1c... Per kw. hr.	165.69	168.21	141.06	120.86	106.97	146.89	13 138.	50.94	76.40	119.03	136.04		$1,370.22		124.56
Labor	390.00	289.00	402.00	425.00	435.00	355.72	355.72	385.74	431.35	427.72	427.72			$4,324.97	393.18
Kansas City—															
Material	94.22	102.68	72.89	118.30	93.87	109.90	107.54	99.07	108.45	133.72	129.93	1,170.57			106.42
Current at 1c. Per kw. hr.	34.00	46.40	40.08	50.99	45.36	41.35	36.48	27.50	36.50	28.26	32.02		418.94		38.09
Labor	145.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00	170.00			1,845.00	167.73
Bloomington Shop Expense—															
Material	160.00	1,941.62*	171.05	42.30	173.01	107.22	9.80	51.38	60.08	14.01	131.94***	2,862.41			260.22
Labor	35.00	75.00	45.67	67.42	160.87	102.48	32.00	20.00	129.03	22.67	148.50			838.64	76.24
St. Louis—															
Current and								315.80	161.95	36.60	No		198.55		18.05
Labor	21.60	21.60	20.50	93.15	143.45				132.00	20.00	Charge			746.50	67.87
Supervision Expense	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00			1,100.00	100.00
Total Cost...	1,544.12	3,214.03	1,444.57	1,534.05	1,711.06	1,488.87	1,282.61	1,567.99	1,746.80	1,394.02	1,956.51	8,041.92	1,987.71	8,855.11	1,716.80
											Ave.	731.08	180.70	805.01	
Tot. number of cars operated.	99	99	100	100	100	102	103	95	100	94	96				99.1
Cost per car per month...$	15.59	$ 32.46	$ 14.44	$ 15.34	$ 17.11	$ 14.59	$ 12.45	$ 16.50	$ 17.46	$ 14.83	$ 20.38				17.35

Note: In compiling this table all expenses of whatever nature have been included, such as:
All salaries of electricians at terminals, and Bloomington.
All material used in lighting and maintaining electric equipment.
All new equipment purchased for replacing worn out equipment.
Electricians at Brighton Park and Kansas City also do work on headlights and yard lighting, but no deduction has been made on this account.
The cars operated include 26 30-volt equipments, 14 60-volt equipments and 60 straight storage and train-line operated cars. The low cost shown is largely due to the fact that only about 5 per cent of the batteries in service were renewed during this period.

*This item includes 96 cells of 300 ampere-hour batteries purchased to replace old cells.
**This item covers 32 positive elements and 32 negative elements for 350 ampere-hour batteries.
***Includes additions to the value of $75 in dining car equipment.

RAILWAY ELECTRICAL ENGINEER

Official Journal of the Association of Railway Electrical Engineers.

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

The Convention.

THE slogan of A. A. Stagg, probably the greatest football coach that ever wore the moleskins, is "Get Together!" He crams into those two words the whole science of successful football. And success in football is achieved by much the same methods as success in any other field, whether it be sport, politics or business. The time is past when a man can climb alone. To do his best work he must take advantage of what other have learned and give others the benefit of what he has learned. The highest efficiency of the individual man, as well as that of the group of men, is attained only when these men get together.

The essential purpose of any convention is to allow the men who come there to get together. "Get together" is the spirit of the occasion. There are reasons why such an opportunity is especially desirable for a group of men such as form the Association of Railway Electrical Engineers. Their work is such that they are widely scattered and have few opportunities to meet and compare notes. The methods of doing this work are continually being altered and improved upon. The scope of their authority is widening every day and they must find new ways and means to meet new needs. True, they can follow the work of others by reading of it in the papers, but that is not like meeting and talking with them. The latter is as much better than the former as the telephone is better than the telegraph. There are many things which can only be accomplished when we get together.

If they get time to think of it, those who attend this convention and have attended those held before, cannot help but marvel at the progress which the Association has made in a life of less than four years. Every convention has been at least 50 per cent better than the one before and there is every reason to believe that this rate of improvement will be kept up for some years to come. Looking at this, the Fourth Annual Convention, from all sides and from all angles, we feel safe in saying that there is no more vigorous and lusty body of men in the country than the Association of Railway Electrical Engineers. It is a vivid vindication of the principle of "Get Together."

The Convention Issue.

AS THE Convention is a record breaking convention, so this issue of the RAILWAY ELECTRICAL ENGINEER is a record breaking issue. It is the largest edition we have ever published, and, we believe, the best. In its pages you will find all the Committee Reports and all the papers to be read. There is no question of the great advantage of having these in printed form. The reports this year are unusually comprehensive and complete. The papers are scholarly and yet with direct practical bearing. Both contain much which will provoke discussion. They are submitted in that spirit and for that purpose. And the word "discussion" is here used in its best sense—that of a comparison of views for the purpose of arriving at the truth—rather than to mean an acrimonious argument in which each speaker tries to prove the truth of his own preconceived opinion.

We bespeak your attention for the advertising pages, because we know they will be just as valuable to you as the reading pages. Advertising of this kind is to the Association proceedings what the Shop Foreman is to the Engineer. The Engineer tells you what to do; the Shop Foreman tells you how to do it. They are complementary and one is as important as the other.

We believe that this Convention Issue is a credit to the Convention, to the Association and to ourselves. We hope you will agree with us.

The Fourth Annual Convention of the Association of Railway Electrical Engineers

Chicago, November 6 to 10, 1911

The fourth annual convention of the Association of Railway Electrical Engineers is to be held at the Hotel La Salle, November 6-10. The entire nineteenth floor is at the disposal of the association during that time.

The officers of the association are:

J. R. Sloan, President.
F. R. Frost, First Vice-President.
D. J. Cartwright, Second Vice-President.
J. Andreucetti, Secretary-Treasurer.

and an Executive Committee composed of C. R. Gilman, A. McGary, A. J. Farrelly, H. C. Meloy, F. E. Hutchinson and C. J. Causland.

All entertainment features have been arranged by the Railway Electric Supply Manufacturers' Association. The officers of this Association are:

A. C. Moore, President.
H. G. Thompson, Vice-President (East).
Geo. H. Porter, Vice-President (West).
J. Scribner, Secretary.
Edward Wray, Treasurer.

and an Executive Committee composed of Geo. H. Porter, R. M. Newbold, J. M. Lorenz, A. J. Cole, W. H. Glatt, J. Scribner, Otis B. Duncan, G. H. Atkin and W. E. Ballantine.

The committees in charge of the various features are as follows:

MEMBERSHIP: J. Scribner.

EXHIBITS: W. E. Ballantine, Chairman; H. W. Young and A. I. Totten.

FINANCE: G. H. Atkin.

AUDITING: R. M. Newbold.

PUBLICITY: Edward Wray.

ENTERTAINMENT: Geo. H. Porter, General Chairman.

Sub-Committees of Entertainment Committee:

RECEPTION AND DANCE: W. M. Lalor, Chairman; Joseph Kuhns, W. P. Hawley, H. G. Thompson, A. C. Moore, H. C. Schroeder and Geo. V. W. Ingham.

AUTO TOUR: O. B. Duncan, Chairman; B. L. Winchell, Jr., A. J. Cole and R. M. Newbold.

THEATRE PARTY: W. F. Bauer, Chairman; W. H. Glatt and F. R. Bryant.

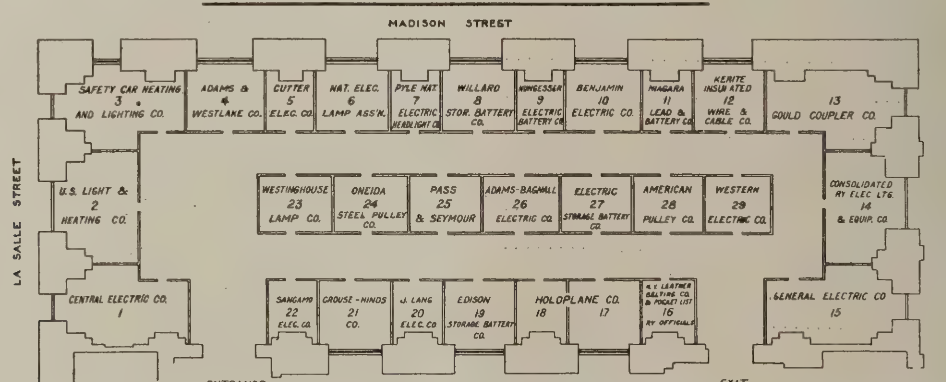
BANQUET: Geo. R. Berger, Chairman; J. J. Schayer and L. J. Kennedy.

SPEAKERS: Geo. H. Porter and W. L. Bliss.

BADGES: J. M. Lorenz.

LADIES ASSISTING

Mrs. J. R. Sloan	Mrs. J. G. Pomeroy
Mrs. J. Andreucetti	Mrs. Geo. V. Ingham
Mrs. F. E. Hutchinson	Mrs. W. E. Ballantine
Mrs. A. J. Farrelly	Mrs. C. W. Bender
Mrs. Geo. B. Colgrove	Mrs. J. M. Lorenz
Mrs. J. C. McElree	Mrs. W. H. Glatt
Mrs. N. E. Lemmon	Mrs. B. F. Fisher



Plan of Exhibit Hall.

Exhibits

Name.	Space No.	Name.	Space No.
Central Electric Company	1	New York Leather Belting Company	½ of 16
United States Light & Heating Co.	2	Pocket List of Railway Officials	½ of 16
Safety Car Heating & Lighting Co.	3	Holophane Company	17
Adams & Westlake Company	4	Holophane Company	18
Cutter Electrical Mfg. Co.	5	Edison Storage Battery Company	19
National Electric Lamp Association	6	J. Lang Electric Company	20
Pyle National Elec. Headlight Co.	7	Crouse-Hinds Company	21
Willard Storage Battery Company	8	Sangamo Electric Company	22
Nungesser Eectric Battery Co.	9	Westinghouse Lamp Company	23
Benjamin Electric Company	10	Oneida Steel Pulley Company	24
Niagara Lead & Battery Company	11	Pass & Seymour	½ of 25
Kerite Ins. Wire & Cable Co.	12	Adams-Bagnall Electric Company	26
Gould Coupler Company	13	Electric Storage Battery Company	27
Consolidated Ry. Elec. Ltg. & Equip. Co.	14	American Pulley Company	28
General Electric Company	15	Western Electric Company	29

Program

TUESDAY, NOV. 7.

Morning Session, 10 A. M.
- Address of President.
- Report of Secretary-Treasurer.
- Unfinished Business.

Afternoon Session, 2 P. M.
- Report of Committee on Data and Information.
- Report of Committee on Ventilation.

WEDNESDAY, NOV. 8.

Morning Session, 9:30 A. M.
- Report of Committee on Standards.
- Report of Committee on Improvements.

J. R. Sloan, President.

Afternoon Session, 2 P. M.
- Report of Committee on Shop Practice.
- Paper on "Insulation," by K. R. Sternberg.

THURSDAY, NOV. 9.

Morning Session, 9:30 A. M.
- Report of Committee on Specifications.
- Paper on "The Gas Electric Car."

Afternoon Session, 2 P. M.
- Report of Committee on Train Lighting Practice.
- Report of Committee on Illumination.

FRIDAY, NOV. 10.

Morning Session, 10 A. M.
- Report of Committee on Accounts and Reports.
- Report of Auditing Committee.
- Election of Officers for ensuing year.

Afternoon Session, 2 P. M.
- Paper on "Industrial Trucks for Railway Service," by T. V. Buckwalter.

Entertainment

MONDAY, NOV. 6.

8:30 P. M. Informal Reception and Dance. Red Room, Hotel La Salle.

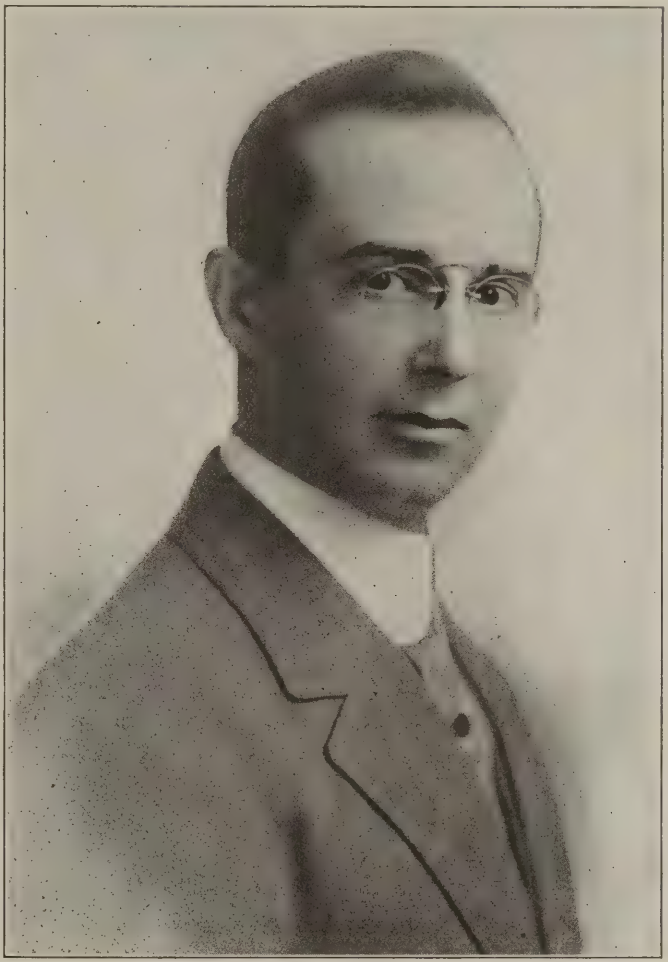
TUESDAY, NOV. 7.

2:30 P. M. Automobile Tour. The tour will start from the Hotel La Salle at 2:30 sharp. Automobiles are at the disposal of all ladies holding badges.

8:30 P. M. Ladies' Night for Viewing Exhibits.

WEDNESDAY, NOV. 8.

2:15 P. M. Matinee party at the Princess Theatre, "Over Night." All ladies holding badges are invited.



J. Andreucetti, Secretary-Treasurer.

8:30 P. M. Car Lighting Club Entertainment for the Railway Electrical Engineers and their friends. Mrs. Morgan S. Woodward will tell of her experiences during the Siege of Pekin.

THURSDAY, NOV. 9.

7:00 P. M. Fourth Annual Banquet given by the Railway Electric Supply Manufacturers' Association to the Association of Railway Electrical Engineers. The banquet will be followed by an informal dance.

Quiet Tip on the Entertainment

From association with the entertainment sharks and experience at past conventions we are able to give some advance dope on this important subject.

In the first place there are two—COUNT THEM—two dances. The first opens Monday night on or about 9 A. D. (after dinner). The dance committee (see page 94)

has spread itself on this affair, being only restrained from springing a lot of new stunts because the chairman, W. M. Lalor, insisted that they be saved for Thursday night when the second slow and dreamy session is scheduled. Thursday night's affair, the fourth annual dance of the A. R. E. E., will start with the finish of the banquet, which, it is hoped, will be over by 10 o'clock.

The auto tour on Tuesday is for all the ladies. It starts at 2:30 sharp, from the front stoop of the La Salle. Tuesday night the ladies are expected to evince an intelligent interest in the exhibits. Acting on the suggestion made in these columns last month, the exhibitors will lay in a stock of the latest developments in the confectionery field.

Wednesday matinee, "Over Night" at the Princess Theater. "Over Night" was written by an engineer, but you would never suspect it. It seems that a cute little man has married a rampant suffragette and a big husky has hitched up with a shrinking violet with a mispronounced lisp, which would be no worse than often happens had there not been a honeymoon mixup in which each drew the wrong bride. You can imagine the rest but the chances are your imagination is not as lively as that of Phillip Bartholomae (the engineer who wrote "Over Night"), so you had better see the play. W. H. Bauer has made all necessary arrangements.

The banquet is Thursday night at seven. Several speakers of known brevity will say a few well chosen words. There will also be an abundance of food. Geo. R. Berger is chairman of the banquet committee.

MEMBERS OF RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION.

Adams & Westlake Company.
Adams-Bagnall Electric Company.
American Conduit Mfg. Company.
American Pulley Company.
A. & J. M. Anderson Mfg. Company.
Benjamin Electric Company.
Bryant Electric Company.
Central Electric Company.
Columbia Incandescent Lamp Co.
Commercial Acetylene Company.
Consolidated Ry. Elec. Ltg. & Equip. Co.
Crouse-Hinds Company.
Cutler-Hammer Company .
Cutter Company.
Diehl Electric Company.
Edison Storage Battery Co.
Electric Appliance Company.
Electric Storage Battery Company.
Fort Wayne Electric Works.
General Electric Company.
Gould Coupler Company.
Haskins Glass Company.
Holophane Company.
Jefferson Glass Company.
H. W. Johns-Manville Company.
Kerite Insulated Wire & Cable Company.
J. Lang Electric Company.
Moon Manufacturing Co.
National Electric Lamp Association.
National India Rubber Company.
New York Leather Belting ompany.
Niagara Lead & Battery Company.
Geo. P. Nichols & Bro.
Nungesser Electric Battery Company.
Okonite Company.
Oliver Electric & Mfg. Co.,
Oneida Steel Pulley Company.
Pass & Seymour.
Pocket List of Railway Officials.
RAILWAY ELECTRICAL ENGINEER.
Republic Rubber Company.
Hugo Reisinger.
Safety Car Heating & Lighting Co.
Sangamo Electric Co.
Sprague Electric Works.
Standard Underground Cable Co.
Tipless Lamp Company.
United States Light & Heating Company.
Wagner Electric Company.
Ward Equipment Company.
Western Electric Company.
Westinghouse Elec. & Mfg. Company.
Westinghouse Lamp Company.
Willard Storage Battery Company.
James Wolff.

The Reports of the Committees

The Association of Railway Electrical Engineers assumes no responsibility for the individual views of its members on the various topics and disavows any action taken on the various subjects except such action as is taken in due course and in accordance with the constitution.

Report of Committee on Accounts and Reports

Your committee present the accompanying form for guidance in preparing reports showing the cost of car lighting.

As it is evident that the items properly included in any report of costs will depend upon the purpose for which the statement is intended, it is recommended that each item included in total costs be shown in the statement in order to prevent misunderstandings; also, that items of interest, depreciation, taxes, insurance, haulage and driving power be included only where unlike systems of lighting are compared or where the cost figures must be exceptionally complete. These items should be omitted from regular periodical statements of service as they have little bearing on maintenance and entail a large amount of labor in determining the amount involved. When included, the rates used for these items should be shown.

The cost of driving power includes many variable factors such as the cost of coal, the efficiencies of engine-men, locomotives, power transmission and generating equipment and the average load, making the calculations very complex.

Repairs and renewals of every sort (except replacement of complete dynamos, engines or regulators discarded after long service) are to be separated and included in the appropriate item.

________________ Railroad

STATEMENT SHOWING PREFORMANCE AND COST OF MAINTAINING ELECTRIC LIGHTING EQUIPMENT PER CAR EQUIPPED PER MONTH.

DURING MONTH OF ________ 19___

BY ________ VOLT ________ METHOD OF LIGHTING.

CLASS OF CARS

	COACHES		SLEEPERS		DINERS		MAIL CARS	
	Material	Labor	Material	Labor	Material	Labor	Material	Labor
INTEREST Rate% ( )								
DEPRECEIATION Rate% ( )								
TAXES Rate % ( )								
INSURANCE Rate% ( )								
HAULAGE Rate ( )								
POWER Rate ( )								
SUPERVISION								
BATTERIES								
GENERATING UNITS								
DRIVE (Belts, fasteners and chains)								
PULLEYS AND SPROCKETS								
REGULATORS								
LAMPS								
CHARGING CURRENT								
SWITCHBOARDS								
WIRING								
WIRE REPAIRS								
SHOP ORDER REPAIRS								
TOTAL								
CREDIT SCRAP MATERIAL								
NET TOTAL								
NET TOTAL COST PER CAR 191								
NET TOTAL COST PER CAR# 191								
NUMBER OF CARS EQUIPPED								
TOTAL MILEAGE								
AVERAGE MILES PER CAR								
AVERAGE COST PER 1000 CAR MILES 19								
AVERAGE COST PER 1000 CAR MILES# 19								
TOTAL NO. OF FAILURES								
FAILURES PER CAR MONTH								
AVERAGE MILES PER FAILURE 19								
AVERAGE MILES PER FAILURE# 19								
AVERAGE AGE OF EQUIPMENT								
AVERAGE COST OF BATTERY								
AVERAGE COST OF GENERATING EQUIPMENT ACCESSORIES AND REGULATORS								
#SAME MONTH YEAR PREVIOUS								

VOLTAGE FALLING BELOW 1.8 VOLTS PER CELL WITH LIGHTS ON CONSTITUTES A FAILURE.

STANDARD FORM FOR CAR LIGHTING COST ACCOUNTING.

The pairs of vertical columns are used to compare the various items of labor and material for different classes of cars.

Interest.

The rate recommended is five per cent (5%) per annum upon the entire electrical investment per car.

Depreciation.

The committee recommended a rate of five per cent (5%) per annum upon the entire electrical investment. This item is intended to cover only obsolescence and such loss in value as cannot be overcome by repairs shown in renewals. A lower rate is now recommended as the apparatus is much nearer standard than previously.

Taxes and Insurance.

Rates vary on different railroads and no recommendation is made. The rate used should be shown.

Haulage of Equipment and Cost of Power to Drive Dynamo.

The committee deemed it inadvisable to recommend any definite rates for these items. The cost of haulage should be taken at a rate less than that taken for company freight as the material does not require loading and unloading except in extraordinary cases, does not require clerical accounting and does not occupy space valuable for transporting other material. The items of haulage and driving power should include only the proper proportion of cost of fuel, water, lubricants, locomotive and car repairs and engine-men's wages.

Supervision.

This item shall include that portion of the time and office expenses of the electrical engineer or chief electrician, his assistants and clerks devoted to car lighting.

F. R. Frost, Chairman.
J. Andreucetti.
F. E. Hutchinson.
E. W. Jansen.
Edward Wray.

Report of Committee on Data and Information

It has been somewhat difficult for your committee to decide upon just what subjects of Data and Information would be most useful to our Association. Therefore your committee submits Data and Information on subjects that the members have occasion to refer to from time to time.

TEST NO.1. PERFORMANCE OF 4-INCH AND 5-INCH AXLE LIGHTING BELTS.

Month	No.Belts Used	Total Mileage	Av.Miles Per Belt	No.Belts Lost	No.Belts Torn & Worn	% Belts Lost	% Belts Worn
1909							
Sept.	24	161,235	6,718	9	15	37.5	62.5
Oct.	9	190,676	21,186	4	5	44.4	55.6
Nov.	17	389,507	22,918	14	3	82.3	17.7
Dec.	81	2,116,220	26,126	43	38	53.1	46.9
1910							
Jan.	51	724,743	14,206	32	19	62.7	37.3
Feb.	53	1,089,435	20,555	42	11	79.2	20.8
Mar.	48	717,486	14,947	30	18	62.5	37.5
April	51	1,276,797	44,643	37	14	72.5	27.5
May	58	1,088,178	18,762	55	3	94.8	5.2
June	85	1,667,587	19,642	71	14	83.5	16.5
July	57	1,502,965	26,877	44	13	77.2	22.8
August	26	888,985	34,192	19	7	73.1	26.9
Sept.	5	271,840	54,368	5	----	100.0	----
Oct.	5	291,156	58,231	5	----	100.0	----
TOTAL	570	12,159,338	21,332	410	160	71.9	28.1

Average Length of Belt ----10' 6"
Average Cost per foot ----- $0.58
Average Cost per Belt ----- 6.09

Average Miles per Belt -----21,332
Average Cost per 1000 miles-$0.285

TEST NO.2. PERFORMANCE OF 4-INCH AND 5-INCH AXLE LIGHTING BELTS.

Month	No.Belts Used.	Total Mileage.	Av.Miles Per Belt	No. Belts Lost.	No.Belts Torn & Worn	% Belts Lost.	% Belts Worn.
1910							
July.	24	48,167	2,007	21	3	87.5	12.5
August	62	498,267	8,037	53	9	85.5	14.5
Sept.	71	752,560	10,599	56	15	78.8	21.2
Oct.	64	729,040	11,235	48	16	75.	25.0
Nov.	55	882,902	16,053	43	12	78.2	21.8
Dec.	111	1,826,605	16,456	72	39	65.0	35.0
1911							
Jan.	116	1,432,620	12,350	94	22	81.0	19.0
Feb.	112	1,133,461	10,120	78	34	70.0	30.0
Mar.	76	886,941	11,670	49	27	64.5	35.5
April	40	553,508	13,863	21	19	52.5	47.5
May	56	959,583	17,135	42	14	75.0	25.0
June	56	737,516	13,170	37	19	66.1	33.9
TOTAL	843	10,441,170	12,385	614	229	72.8	27.2

Average length of Belt ----10' 6"
Average Cost per foot ----- $0.42
Average Cost per Belt ----- 4.41

Average Miles per Belt -----12,385
Average Cost per 1000 miles-$0.34

Acting upon the suggestion of Mr. Cartwright, chairman of this committee last year, we submit an authentic statement of electric-lighted cars operating on the various railroads in the United States as shown in the accompanying table.

Axle Lighting Belts.

The following data shows why belts are lost and the various causes. It was compiled from 92 belts found on the right-of-way:

	Per Cent.
Belts lost due to careless application	26 to 28
Belts lost due to dynamo out of line	22 to 24
Belts lost due to poor inspection	20 to 22
Belts lost due to striking brake beam	10 to 11
Belts lost due to miscellaneous causes	14 to 15
	92 to 100

Careless application shows, belts not cut straight, rivets which are not clinched properly and clamps put on crooked.

Poor inspection shows belts that have broken at the clamps and which should have been repaired at the last terminal the car left.

Of the 92 belts shown above invariably the belts have been broken at the clamps or rivets pulled out, showing the necessity for a new and better fastener for belts operating in this service. This data also shows the necessity of careful instructions being given the men who apply the belts.

Two tables are given showing the records of two tests, each extending over a period of one year, on the performance of axle lighting belts. These records were very carefully kept, and it is believed that the results shown tell pretty nearly just what service these belts are giving on the average railroad

The accompanying drawing gives a method for locating the axle pulley and aligning the dynamo. With this method no attention need be paid to the lateral motion of car wheels as the pulley will play an equal distance each side of the center line.

Cost of Lamps.

Attention is called to the curve showing the actual cost of lamps in electric-lighted cars per car per month for nearly four years. It will be noticed that since the more efficient lamps have been used this average cost is higher, but these costs are not credited with reduced deprecia-

STATISTICS ON ELECTRIC CAR LIGHTING.

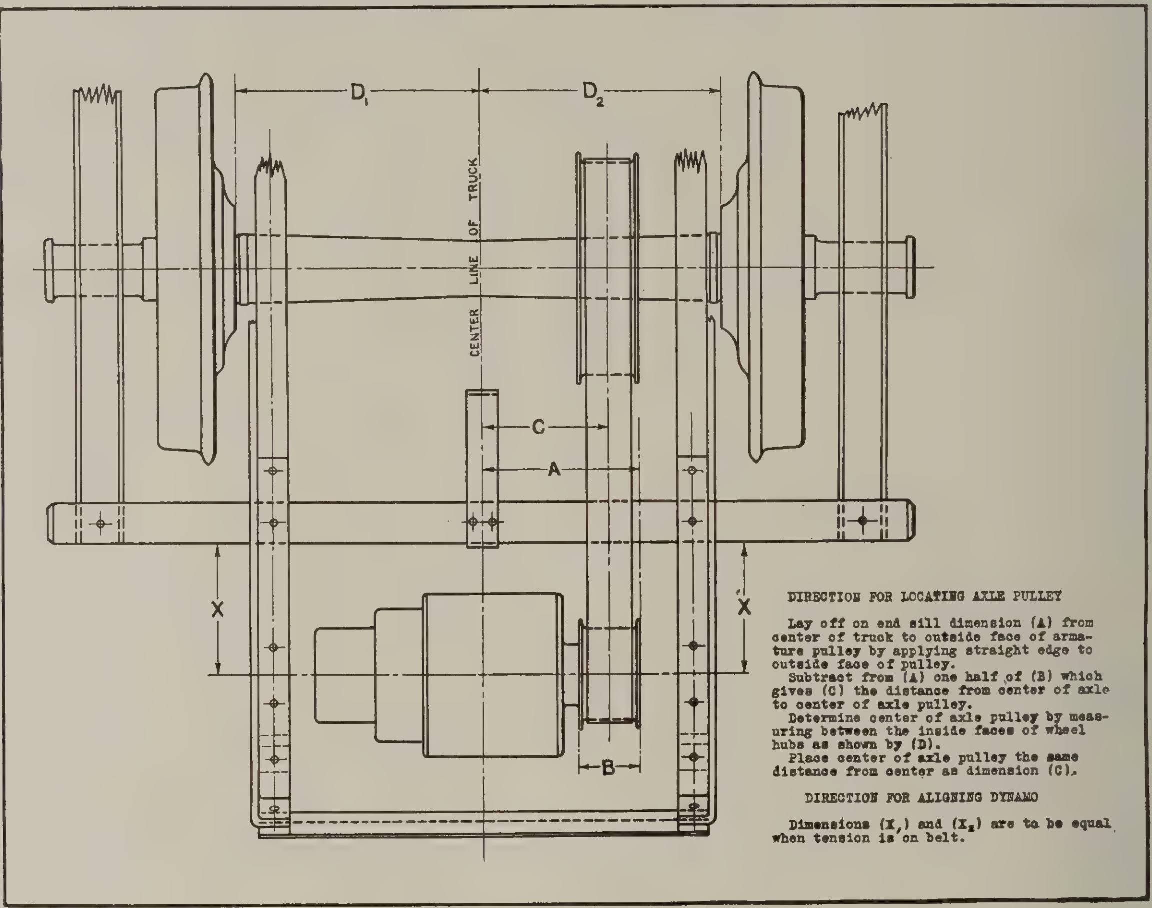
	Electric lighted Cars.	Cars lighted by other means.	Straight Storage.		Cars with Turbine Set.	Head End System.		Axle Gen. System.		Cars Wired Only†	Cars owned and operated by R. R. Co.	Cars contracted for.		Cars on Rental.	Pullman Co. Cars with R. R. Co. Devices.	Pullman Co. Cars with Pullman Devices.	Number of Cells of Batteries.
			No.	Volts.		No.	Volts.	No.	Volts.			No.	Eq'p't.				
A. T. & S. F.	583	891						583	32		432	17			82	151	8016
Boston & Albany	23	430						23	64		6					12	192
Baltimore & Ohio	132	1212	16	32/64	11	73	64	43	32/64	23	106	74	Head End	61		26	3188
Canadian Pacific	68	2008						68	24		68						1602
Chgo., St. Paul, Mpls. & Omaha	74	350			3	68	110	6	32/64		70			4		4	192
Central of Georgia	5	249						5	32	2	5						128
Chgo. & Alton	103	100	56	32/64				34	32/64	13	103						
Chgo. & Eastern Illinois	50	107	2	32				62	32		50	7	Axle	12		12	1024
Chgo., Burlington & Quincy	702	611			48	702	110				702						
Chgo., Milwaukee & St. Paul	886	368	30	64		300	64/110	11	32/64	6	886						4544
Chgo. & Great Western	75	104						75	32		58					17	1677
Chgo. & North Western	500	907			19	459	110	41	32/64		500			8		8	2176
Chgo, Rock Island & Pac.	258	836						258	32/64		258	17	Axle				4448
C. C. C. & St. L.	46	552	2					44	32/64		46						1146
Dela., Lack. & Western	30	703						13	32		13	5	Axle			17	224
Denver & Rio Grande	25	525						25	32/64		25						418
El Paso & So. Western	16	36						16	32		16						256
Erie	71	1834	2	32				69	32		71	35	Axle			38	1408
Great Northern	480	660			39	480	110				480						2106
Grand Trunk	26	1032						26									
Fort Worth & Denver	22	31						22	32		22			20		20	352
Illinois Central	113	771	12	32				101	32/64		109			90	4	90	2432
Kansas City & Southern	21	57						21	32/64		3			18		18	384
Lehigh Valley	81	392						81	32		81	55	Axle	44		44	1877
Long Island	11	687	2					9			11						
Lake Shore & Mich. Sou.	34	648						34	32/64		34	12	Axle				1138
Louisville & Nashville	49	554	1					48	32		49	7	Axle				1135
Missouri Pacific	77	626	2	32				77	32		77			14		14	1264
Mobile & Ohio	6	119						6			6						
Minneapolis & St. Louis	17	76						17	32		17						272
Michigan Central	35	605						35	25/32/64		35	10	Axle				1261
M. St. P. & S. S. M.	60	292						60	32		60						960
New York Central & Hudson River	202	1755			1			202	32/64		202	70	Axle				4144
New York Chgo & St. Louis R. R.	4	98						4			4						
New York, New Haven & Hartford	350	2081						350			350						
Northern Pacific R. R.	641	511			52	637	110	4	32/64		641						34.364
National R. R. of Mexico	18	353						18			18						
Norfolk & Western	13	390						13			13						
Oregon Short Line	76	173			6	75	110	1	32		76	32					480
Oregon R. R. & Naviga.	81	87			7	77	110	4	32/64	2	66			15		15	480
Pittsburg & Lake Erie	4	127	2	32/64				2	32/64		4						80
Pere Marquette	102	259						102	32		102			12		12	1632
Pullman Co.	2400	1864						2400									38400
St. Louis & San Francisco	156	438	6					148	32		156	84		62			2496
St. Louis South Western	4	155						4			4						
Southern	229	850						229	32		229						4144
Southern Pacific	145	1400	2			71	110	72	32/64		145						2200
S. P. O. S.	30					30					30						
S. P. L. A. & S. L.	76	97	1		6	55	110	20	32/60	31	24			16			608
Texas & New Orleans	16	533						16	64		16			47		47	512
Trinity & Brazos Valley	17	12						17	32		17						272
Union Pacific	177	351				158		19	32/64		177						
Wheeling & Lake Erie	4	72	3					1			4						
Western Pacific	90							90	32		90						1592
Pennsylvania	902	2743	703	32/64				199	32/64		902	209					42464
Penn. Lines W. of Pitts.	516	697	460	32/64				56	32/64		516	23					21728
Vandalia	51	118	40	32/64				11	32/64		51						2096
Grand Rapids & Indiana	34	79	29	32				5	32		34						912
Totals	11017	33634*	1372		192	3185		5900		77	8270	657		423	86	545	202744

*Note: The total number of passenger cars in the United States is about 50,000.

†Additional to cars listed in first column.

tion on batteries and equipment, nor reduced cost of power. They take no account of the improved service rendered by the more expensive lamps and the fewer light failures on account of the reduced discharge of the batteries. They are simply the actual costs of the lamps alone.

fully charged. This curve is not to be taken as correct for all batteries. In fact, every make of battery has its own characteristic curve. The committee recommends that battery makers furnish these curves for their batteries so that stop-charge devices can be set intelligently without experiment.



Method of Locating Axle Pulley.

Stop Charge Voltage.

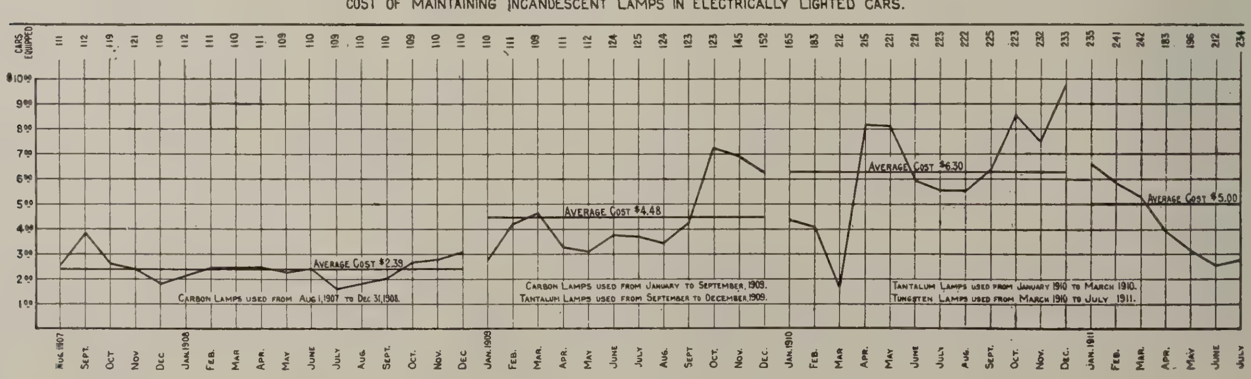
A curve is shown which gives the voltage at which a stop charge device should be set to cut off the current at the time when the battery is fully charged for various charging rates. This curve was plotted from actual values obtained by test. It shows that the higher charging rate the higher the stop-charge voltage must be. If the stop is set at a lower voltage than the one proper for that charging rate it will operate before the battery is

Electric Headlights.

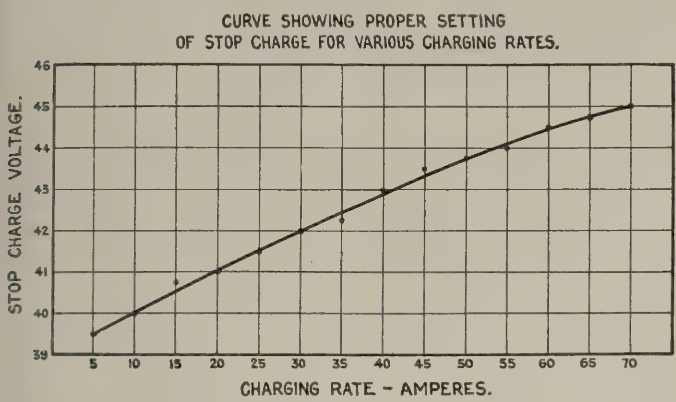
A method of focusing electric headlights is given. This method is in daily use on a railroad using a very large number of these headlights, and has proven very satisfactory. Included with it are the instructions issued as a bulletin of the electrical department for applying the method.

The committee believes that exact cost data on electric headlight equipment may be of value. The following

COST OF MAINTAINING INCANDESCENT LAMPS IN ELECTRICALLY LIGHTED CARS.



table, showing the actual cost of labor and material necessary to equip a locomotive with electric headlight and cab lights, is therefore given:



Curve Showing Variation of Stop-Charge Point with Charging Rate.

LABOR AND MATERIAL FOR EQUIPPING ONE LOCOMOTIVE WITH ELECTRIC HEADLIGHT AND CAB LIGHTS.

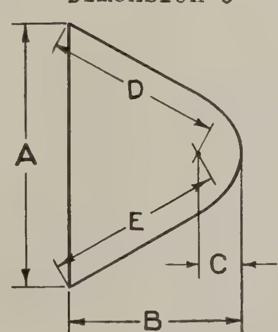
1 dynamo, arc light and case (price variable.)		
35 ft. ¾-in. galvanized conduit	$ 2.00	
3 ft. 1-in. conduit	.22	
1 No. T 23200 condulet	.47	
1 No. B 3400 condulet	.44	
2 No. 19168 ¾-in. conduit bushing	.04	
75 ft. No. 8 D. B. R. C. solid wire	1.35	
70 ft. No. 14 D. B. R. C. solid wire	.70	
8 ft. No. 16 lamp cord	.10	
5 8 C. P. 40-v. lamps	.80	
1 No. 62965 fuse block	.09	
2 10-amp. fuse plugs	.02	
25 ft. ¼-in. 2 wire moulding and capping	.25	
3 No. 926 cord rosettes	.33	
1 No. 9184 key wall sockets	.26	
1 No. 9185 keyless wall socket	.23	
1 No. 50760 key socket	.21	
2 No. 50768 keyless sockets	.17	
3 socket bushings	.02	
½ lb. wire solder	.13	
½ lb. friction tape	.15	
½ lb. okonite tape	.57	
1 ¾-in. high-pressure steam valve	3.20	
1 ¾-in. steam pipe	.05	
1 1½-in. exhaust pipe	.12	
4 ¾-in. x 2½-in. boiler studs	.12	
30 ¾-in. No. 6 brass screws	.05	
30 1¼-in No. 9 F. H. iron screws	.03	
4 ⅛-in. x 2-in. F. H. stove bolts	.01	
2 turbine brackets	3.50	
1 No. M 6324 bushing	.01	
10 1-in. No. 8 R. H. iron screws	.02	
5 handrail clamps	2.50	
10 ft. ¼-in. drain pipe	.10	
		$18.26
1½ hours for tinner, at 30 cents	$ .45	
2 hours for pipefitter, at 30 cents	.60	
2 hours for boilermaker, at 40 cents	.80	
10 hours for electrician, at 33 cents	3.30	
10 hours for helper, at 20 cents	2.00	7.15
		$25.41
	10%	2.54
Total labor and material less cost of dynamo, arc light and case		$27.95

To the above freight, supervision, etc., must be added.

INSTRUCTIONS FOR FOCUSING ELECTRIC HEADLIGHTS

Size of Reflector. B	A	Focal Points. C
8"	16"	2 "
8-1/2"	17"	2 1/8 "
8-1/2"	18"	2 5/16"
9"	18"	2 1/4 "
9-1/2"	18"	2 3/16"
10-1/2"	18"	1 3/8 "
11-1/2"	18"	1 3/4 "
12"	18"	1 3/4 "
12-1/2"	18"	1 5/16"
13"	18"	1 9/32"
14"	23"	2 5/16"

Dimensions D & E must be the same horizontally.
Dimensions A & B = Size of Reflector.
Dimension C = Focal points for different sized reflectors.



$$\frac{(1/2\ A)^2}{B \times 4} = C$$

Formula for finding focal distance.

INSTRUCTIONS FOR FOCUSING ELECTRIC HEADLIGHTS.

First: Headlight case must be set square on engine.

Second: Front edge of reflector must be parallel with front of headlight case.

Third: To focus lamp, expose copper electrode 1¼ in. above holder while taking dimensions; after lamp has been properly focused, drop copper electrode down ¼ in. in order to bring arc in center of reflector.

Fourth: If headlight is equipped with old oil lamp reflector, the holes in the reflector should be cut out by filing until there is plenty of room to focus light without carbons touching reflector.

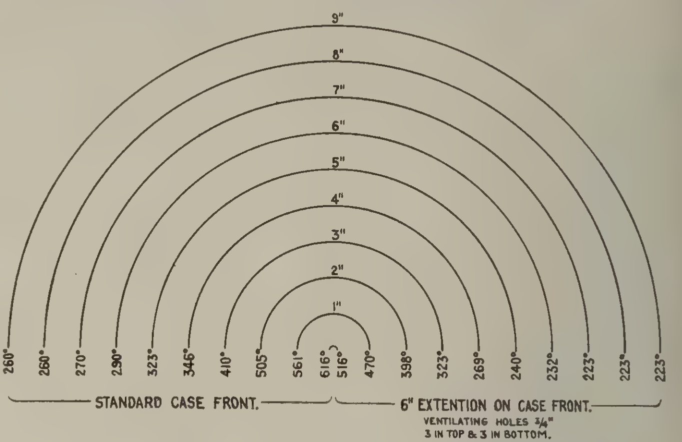
Fifth: Lamp can be focused more satisfactorily at night, without observing dimensions, when engine is on a straight track.

Sixth: If the holes in lamp base are not in the proper position to allow the lamp to be moved to proper focal point, drill new holes so it can be so adjusted.

Seventh: After hand nuts have been tightened, go over the measurements again to see that the tightening of lamp has not changed them.

One of the great troubles with electric headlights has been breaking of the glass. The accompanying drawing, showing the results of a temperature test on an 18-inch flat plate headlight glass, shows conclusively why flat plate headlight glasses break, due to uneven strains, on account of variation in temperature between different parts of the glass. Twenty oval heat-resisting glasses and 10 one-fourth-inch flat plate glasses were tested. The oval glasses could expand, due to their shape. None of the 20 oval glasses, in service six months, were broken. All of the 10 flat glasses, in service two months, were broken.

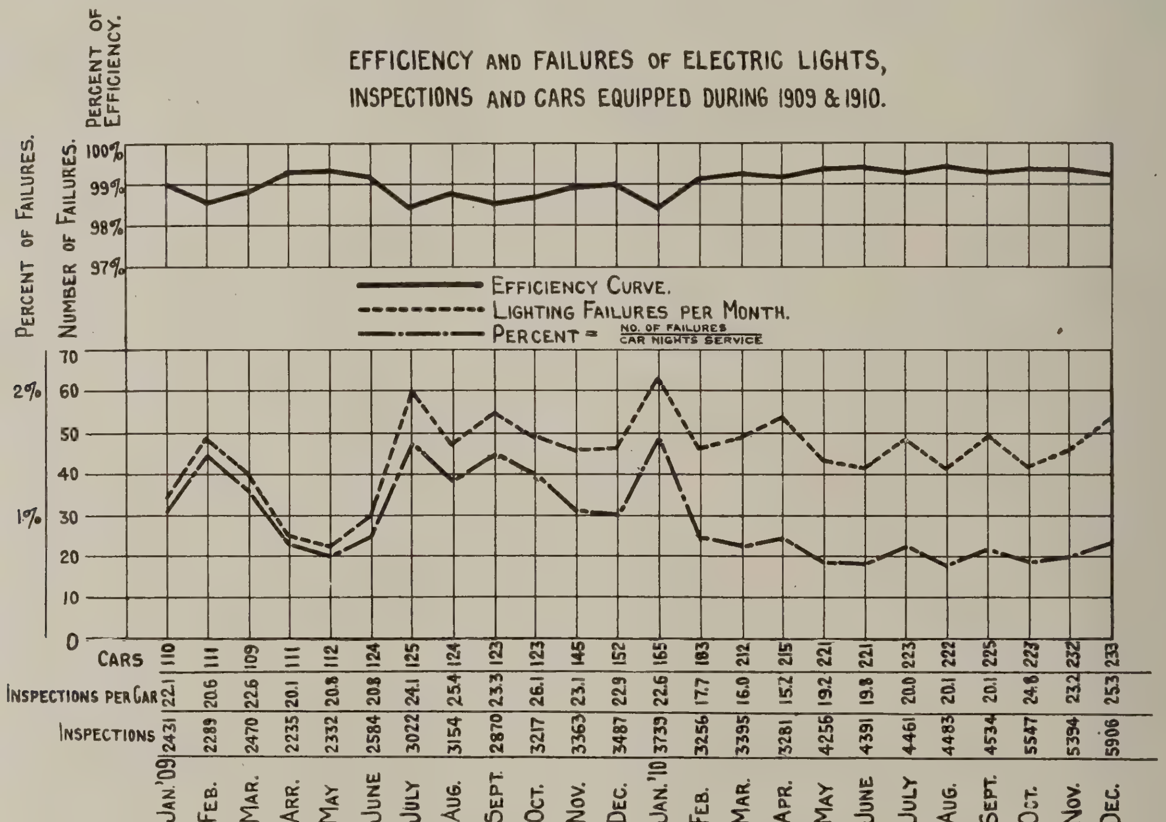
TEMPERATURE OF 18" ELECTRIC HEADLIGHT GLASS.



Result of Temperature Test on Electric Headlight Glass.

Efficiency of Electric Car Lighting.

Finally, there is a curve showing what the committee has termed the "efficiency of electric car lighting." The ratio of the number of lighting failures to the number of car-nights of lighting is arbitrarily taken as indicating the efficiency of the service. Thus, if the percentage of failures to car-nights is three, the efficiency is said to be 97 per cent. The curve is made up from the records of the years 1909 and 1910 on one railroad. It shows the number of cars in service, the ratio of failures to car-nights, and the "efficiency" for the various months. It also shows the total number of inspections during each month and the number of inspections per car per month. Apparently the efficiency tends to rise as the number of inspections per car is increased. So many variable factors come in here, however, that deductions are unsafe.



	Jan. '09	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. '10	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Cars	110	111	109	111	112	124	125	124	123	123	145	152	165	183	212	215	221	221	223	222	225	227	232	233
Inspections per Car	22.1	20.6	22.6	20.1	20.8	20.8	24.1	25.4	23.3	26.1	23.1	22.9	22.6	17.7	16.0	15.2	19.2	19.8	20.0	20.1	20.1	24.6	23.2	25.3
Inspections	2431	2289	2470	2235	2332	2584	3022	3154	2870	3217	3363	3487	3739	3256	3395	3281	4256	4391	4461	4483	4534	5547	5394	5906

Curve Showing "Efficiency" of Electric Car Lighting.

Owing to the difficulty that your committee had in determining subjects best to furnish Data and Information on we recommend, for the help of the next committee, that there be some discussion as to subjects on which we would like the next committee on Data and Information to work.

F. E. Hutchinson, Chairman.
E. M. Cutting.
E. W. Jansen.
S. G. Carlson.

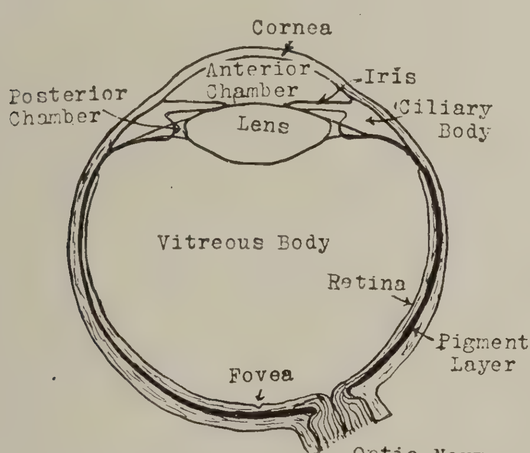
Report of Committee on Illumination

Illuminating engineering differs from most of its sister sciences in that it lies not wholly within the field of physics but partially within the fields of physiology, psychology, and aesthetics. Like the purely electrical engineer, the illuminating engineer may classify his problems as generating, controlling and utilizing the particular form of energy with which he has to deal. The generation and control of light is a subject coming entirely within the realm of physics. This is not true with the utilization of light. The utilizing or receiving apparatus of the illuminating engineer is not a motor of copper or steel, but the human eye and the human brain. For the illuminating engineer to attempt to solve his problems without a knowledge of the physiology of the eye and the psychology of vision would be as ridiculous as for an electrical engineer to cut in a motor on his lines with inadequate knowledge as to its type, capacity and operating characteristics.

The following description of the eye is taken from the paper of Dr. Nelson M. Black before the Illuminating Engineering Society in New York, January 12, 1911.

Visual Apparatus

"In order that the results obtained by various investigators may be fully understood, it is thought best to give a brief description of the different parts of the visual apparatus, although, probably all illuminating engineers are familiar with them.



Cross Section of the Human Eye.

"In order to produce a visual impression a ray of light must pass through several transparent media each of which has the power of absorbing a portion of the rays it transmits. In their respective order these are: (1) the cornea; (2) the aqueous humor; (3) the crystalline lens; and (4) the vitreous body. (See Fig. 1.)

"The ray of light finally impinges upon a complex nervous mechanism, the retina, which is the innermost tunic and perspective structure of the eye, formed by the expansion of the optic nerve. This tunic consists of ten layers; of these only the two outer layers particularly interest us. These are the layer of rods and cones, and the pigmentary layer. The layer of rods and cones forms the percipient element of the retina, in the center of the posterior part of which is the malcula lutea, the most sensitive portion of the retina, and in the center of the malcula lutea is a depression, the fovea centralis, the point of sharpest vision. In the fovea only cones are to be found. Immediately external to this area each cone is surrounded by a ring of rods. The number of rods around each cone increases as the periphery is reached. The outer segments of the cones are situated in a space which is filled with fluid and an external lining membrane retains this fluid in place.

"The cones are supposed to be the form-receiving and color-perceiving elements of the retina; in other words, they are the visual cells.

"The supposition is that the rods are the special apparatus for vision in dim lights (night vision). They contain a pigment known as rhodopsin or visual purple, which is very sensitive to light. This visual purple is found only in the external segments of the rods; the cones do not contain it; therefore the fovea, which has only cones, does not contain it. It has been shown that a photograph may be made upon the surface of the retina by the bleaching of the visual purple where it is exposed to light. In the readily decomposed by the mechanical or chemical effort visual purple, there is, therefore, an unstable substance of the other waves. Some radiations are very much more active than others in bleaching this substance, greenish yellow being most active, yellow next, blue next, violet next and red least active in this process. It has been shown that provision exists in the retina for the constant regeneration of the visual purple. The restoration process takes place rapidly in dim light or darkness. The external segments of the rods impinge upon a layer of heavily-pigmented cells—the pigmentary layer mentioned above. When the eye is exposed to light, the black pigment of these cells migrates so as to be in position to restore the color to the bleached or used up visual purple."

Nature protects the eye from above by the eyebrows, eyelashes and upper eyelid, and from below by the lower eyelid. The eye is practically protected from changes in light intensity by the automatic operation of the pupil. The eye has little natural protection from below. This accounts for the eye distress when the ground is covered with snow or when looking over a body of water with the sun shining on it. Furthermore, it seems probable that the retina is not accustomed to receiving light from below and consequently is abnormally sensitive to illumination from this direction.

Glare

One of the important things to be reckoned with in arranging for artificial illumination is glare. The glare may be either from the lamps themselves, or by reflection from smooth paper or metal. This latter glare from paper is largely the cause of the complaints we hear of the lighting in our freight offices and other places where constant desk work is done under the individual lamp drop cord system. The more localized the lighting and the nearer the lamp to the paper, the greater the amount of trouble likely to be experienced from this kind of glare. The word glare is used to cover a number of conditions. It is usually applied to light either direct or reflected, which causes either annoyance or partial temporary blinding of the observer. One definition of glare which has been suggested is that glare is light out of place. In other words it is light which is allowed to shine in the eyes in such a way as to cause annoyance, discomfort, or a reduction in the ability to see clearly. There is reason to believe that these two effects, namely (1) annoyance and (2) reduction of visual acuity, or ability to see clearly, do not vary in the same proportion. There is some reason to believe that there may be considerable annoyance from glare in cases where there is no real reduction

in the ability to see clearly. These matters are difficult to investigate and have never been investigated to a conclusion. Discomfort or annoyance from glare is largely a matter of contrast of the lamp with its surroundings. As a general principle, the darker the surroundings the less the candlepower of lamps required to produce an annoying glare.

Mr. Percy W. Cobb, in his Baltimore lecture before the Illuminating Engineering Society in 1910 says, "A light source in the field of vision is always an invitation for direct vision. There is always a tendency to look directly at the light source. This is best seen in children perhaps, but is nevertheless even in those that habitually resist it a potent factor in distributing fixation of vision on the object we wish to look at. In this way the same amount of light coming to the eye from a source of small area is much more of an object to fasten the attention than a large one."

For the foregoing reasons illuminating engineers are trying to keep sources of light as far out of the ordinary line of vision as possible. They are also covering lamps with diffusing globes and reflectors, and in some cases resorting to indirect lighting by reflection from large ceiling areas to avoid these detrimental glare effects.

Glare from paper becomes less the greater the number of directions from which light is received on the paper. In other words, the more diffuse the lighting, the less the glare from the paper.

Terms and Units

The following are some of the more common terms used in connection with illumination:

The international candle is the unit of light now used by England, France and the United States. An international candle power is 1.6 per cent less than the British candle formerly used as standard in this country.

A foot candle is the intensity of illumination on a surface one foot distant from a light of one candle power. Since the intensity in foot candles varies inversely as the square of the distance, a 16 candle power lamp would give one foot candle on a surface 4 feet distant.

The horizontal candle power of an electric incandescent lamp is the candle power measured horizontally with the lamp in an upright position. Incandescent lamps for many years have been commonly rated in horizontal candle power.

Mean spherical candle power is the mean average candle power given in all directions by a lamp.

The spherical reduction factor is the factor by which the mean horizontal candle power must be multiplied to obtain the mean, spherical candle power of an incandescent lamp. This must be determined by tests for any given type of filament. The spherical reduction factor on tungsten lamps is from .77 to .80.

Quantity of light given out by a lamp or received on any surface is expressed in lumens.

A lumen is the amount of light required to illuminate an area one foot square to an intensity of one foot candle. A lamp of one mean spherical candle power placed in the center of a sphere of one foot radius will illuminate the entire interior surface of the sphere to an intensity of one foot candle. Since a sphere of one foot radius has an area of 12.57 square feet, the total number of lumens delivered by this lamp of one mean spherical candle power will be 12.57. Hence to obtain the number of lumens given by a lamp, multiply its mean spherical candle power by 12.57. American lamp manufacturers now commonly publish the lumens given by each type of lamp on the regular tables pertaining to that lamp and they are given in the tables in this report. This greatly facilitates rapid illumination calculations as will be explained later.

The lumens per watt given by a lamp is the total number of lumens divided by the watts required to light the lamp to the given number of lumens.

The lumens per watt of lighting installation such as a room or car is the total number of lumens delivered on some working plane (for example 30 inches from the floor) divided by the number of watts required by the installation. To determine the number of lumens delivered on the working plane measurements of the intensity in foot candles are taken at regular intervals over the entire plane and the average foot candles multiplied by the number of square feet of the room gives the total number of lumens delivered on the working plane.

The efficiency of light utilization, or as it is frequently termed for short "the efficiency" in any lighting installation is the percentage of the total lumens of the lamps which reaches the working plane selected for measurement.

Calculation of Illumination

It is hardly within the province of this report to go into an extensive explanation of the methods used in the calculation of illumination as there are now a number of books from which these methods can be obtained.

It may be well, however, to explain a short cut method frequently used by some of those having the calculation of illumination of ordinary rooms to deal with constantly. In a large room the first step is to decide upon the foot candles intensity which is desirable for the place in question. For constant reading it is well to provide at least two foot candles, while if closer work like drafting is to be done from 5 to 10-foot candles will not be too much.

Having determined the number of foot candles probably necessary, the second step is to multiply this average foot candles required by the number of square feet in the room. The result is the total lumens required. The total lumens required is then divided by the percentage of efficiency assumed for the installation in question. This efficiency factor is determined from actual measurement of various installations. Efficiency figures applying to certain conditions are given in Table I. The total lumens required divided by the efficiency percentage gives the total amount of lumens which must be provided by the lamps. By reference to the tables of lamp data, the number and size of lamps required to give the total lumens necessary can be selected. The location and spacing of the lamps is a matter too complicated to take up here at length. Each lamp or group of lamps at an outlet should be considered as illuminating a given amount of floor area depending upon the equipment of the lamp as to reflectors, etc. For this reason it is important to have the photometric curves showing the distribution of light about the lighting unit under consideration. In the absence of this, manufacturers' rules as to spacing of units for uniform illumination may be taken.

It is not feasible at this time to give any efficiency constants for use in calculating car illumination, as car illumination has not been sufficiently investigated to make this possible.

The accompanying table of efficiency factors (Table I) gives factors frequently applied in illumination calculations of ordinary rooms as based on various tests. These should be increased from 10 to 50 per cent on account of dirt or other depreciating causes.

It is hoped that by another year much more information on the efficiency of car lighting will be available, and it is recommended that the illumination committee of next year give this matter serious attention. It is also recommended that next year's committee take up the matter of a satisfactory minimum standard of

illumination to be maintained in electrically lighted cars. Members of the committee who have given this matter the same attention are inclined to believe that a minimum in the neighborhood of 2-foot candles will be a reasonable and satisfactory requirement, but would recommend further investigation.

RAILROAD STATION LIGHTING

The following discussion is intended to review the present practice relating to Railroad Passenger station lighting. This general subject may be sub-divided into its component parts, viz: Approaches to stations, waiting rooms, baggage rooms, offices (private and general), dining rooms, and lunch rooms and counters.

lamp is most generally used because it lends itself well to artistic layouts. The question of chandeliers versus individual units must be solved by compromising between light distribution and architectural appearance.

In general it may be said that the fewer the number of light centers, the more pleasing the artistic effect. On the other hand, as pointed out above, too few light centers may produce objectionable lack of uniformity as well as appreciable shadows. The properly designed installation will strike a proper balance between these considerations.

The larger the number of smaller units the nearer we approach to uniform illumination and absence of shadows, but as we go to the smaller units the maintenance cost increases so we must further compromise between uniformity of illumination and cost of maintenance.

TABLE I. APPROXIMATE EFFICIENCY FACTORS WITH NEW LAMPS AND CLEAN GLASSWARE.

Equipment	Color of Walls	Color of Ceiling	Dimensions	Ceiling Height	Per cent Efficiency
Prismatic or opal reflectors at ceiling	light	light	40′ x 40′ or more	10′ to 16′	55 to 65
Prismatic or opal reflectors at ceiling	dark	light	40′ x 40′ or more	10′ to 16′	50 to 60
Prismatic or opal reflectors at ceiling center	light	light	15′ x 15′	8.5′ to 10′	50 to 60
Prismatic or opal reflectors at ceiling center	dark	light	15′ x 15′	8.5′ to 10′	45 to 55
Prismatic or opal reflectors at ceiling center	dark	dark	15′ x 15′	8.5′ to 10′	30 to 40
Bare lamps at ceiling center	dark	light	15′ x 15′	8.5′ to 10′	30 to 40
Bare lamps at ceiling center	light	light	15′ x 15′	8.5′ to 10′	40 to 50
Bare lamps at ceiling center	dark	dark	15′ x 15′	8.5′ to 10′	20 to 30
Indirect cove	light	light	30′ x 50′	15′ to 18′	15 to 25
Indirect efficient conical reflectors on central fixtures	light	light	40′ x 40′ or more	10′ to 15′	34 to 44
Indirect efficient conical reflectors on central fixtures	light	light	15′ x 15′	8.5′ to 10′	32 to 42
Indirect efficient conical reflectors on central fixtures	dark	light	15′ x 15′	8.5′ to 10′	22 to 32

This class of lighting in common with the other systems of illumination must be planned with a view to maximum efficiency consistent with minimum cost of installation and maintenance. In cases, however, it is wise to make a sacrifice in efficiency to provide a system of lighting that will conform to the general architecture of the room; waiting rooms, and dining rooms are examples where the aesthetic considerations should be given weight in the design.

The spacing and height should be chosen with a view to providing a uniform illumination over the useful working plane and avoid the placing of units of high intrinsic brilliancy in the direct line of vision, resulting in a disagreeable glare. Local lighting should be provided for by low candle power lamps properly equipped with a suitable reflector to screen the light from the observer's eyes and direct the light in the most useful direction.

Station Approaches

A low general illumination is required along the approach to a station to facilitate the ready access and exit from the station by pedestrians and vehicles. A low candle power unit enclosed in a diffusing sphere is preferable for this class of lighting rather than a high candle power unit with its tendency to dazzle the approaching patrons. Ornamental iron or concrete standards will add to the attractiveness of the system in most installations.

Waiting Room

A general illumination of sufficient intensity to permit of convenience in reading is required in the waiting room. The choice of sizes and type of unit will of course depend on the interior construction and size of the room; large units being favorable for high intensities, high ceilings and large rooms, small units favoring the reverse conditions. The incandescent

Baggage Room

A medium general illumination augmented by local lighting over the attendant's desk and receiving window, will generally suffice for this class of lighting. High efficiency incandescent lamps equipped with suitable reflectors suspended close to the ceiling are well adapted for the general lighting, while low candle power carbon lamps and opaque reflectors will provide the required local lighting. Where storage bins, used for checking parcels, are required to be lighted, a low candle power carbon lamp equipped with a reflector to concentrate the rays on the bins and suspended on a drop cord will in most cases meet the requirements.

Offices

Because of the exacting nature of office work, a strong general illumination with as large units as is consistent with good distribution, is productive of good results. The lamps should be suspended near the ceiling and provided with reflectors to avoid glare and secure even distribution of light. This system of providing a good general illumination makes the lighting independent of furniture arrangement, and discourages the use of the local light with its unsightly appearance, glare and cost of maintenance. Local lighting is also to be discouraged because it invites rearrangement, such as changes in mounting height and type of reflector or lamp, by the desk users, who are rarely qualified to make such rearrangement.

A slightly lower intensity will suffice in a private office where little clerical work is done.

General indirect lighting is also finding favor for office illumination, its strong point being absence of glare and annoying shadows.

Yards

It is needless to emphasize the necessity of providing a good reliable system of illumination in the classification yards; here cost of installation and maintenance should be subordinate to reliability of service and proper intensity and distribution. The character of the work requires that the space between the cars, tracks and switches be properly lighted regardless of how dark the night or bad the weather. Safety to workmen and the economical handling of the cars are essential to keep in mind.

The properties of a lamp chosen for this class of work should be good distribution, reliable action and a color of light suitable for penetrating smoke, fog, etc. The flame lamp with its penetrating yellow flame and high efficiency, lends itself admirably to this class of work. The development of the long life electrodes has added an impetus to the adaption of this type of lamp. Large type Tungsten filament lamps are now developed that, used under suitable reflectors, are also useful for this class of work. The unit should be suspended high in order to avoid decreasing the ability of the eye to see and to eliminate shadows between cars. Units should be spaced to provide an even illumination of sufficient intensity to make the lettering on the car legible at the required distance.

The lighting requirements in the terminal yard are possibly slightly less severe but can be handled in about the same manner.

Shops

The lighting of shops is a very broad question envolving as it does many classes of work and types of buildings. Each shop is a problem in itself and can be successfully solved only by a study of local conditions and requirements which determine the type of lamp, its height and equipment.

The usual practice is to provide a good general illumination and augment this with local lighting at the tool when necessary.

An essential feature of a well-lighted shop, when only general lighting is employed, is uniformity of intensity; a low but sufficiently uniform intensity being preferable to a high intensity characterized by brightly lighted spots which make the less brightly lighted spots appear dark by contrast.

Uniformity is favored by a large number of small units while low maintenance, low initial cost of lamps, wiring, etc., are obtained by a fewer number of larger units. The type of unit then and its spacing must be chosen after due consideration of the conditions, preference being given to as large a unit as possible consistent with a reasonably even distribution of light.

Care should be exercised in the placing of the lighting to avoid excessive glare. This is taken care of in the choice of unit, type of reflector and height of suspension. Obviously the best solution is to use low candle power lamps for bays with low ceilings and vise versa.

Local lighting at machine tools is best obtained by a low candle power lamp equipped with a metallic reflector to concentrate the light on the work and to shade the eyes of the workman from the bare filament. This reflector should be mounted in such a way that the light rays do not strike the workman's eyes.

Dining Room

Here the artistic considerations predominate, efficiency being a secondary consideration. A good general illumination of a pleasing color should be provided, floor outlets being installed to afford ready connections for candelabra, and other table decorative schemes.

Lunch Room, Counters, Etc.

A less artistic scheme of lighting answers in lunch rooms, a good general illumination, favoring the counters slightly, will in most cases meet the requirements.

The following tables give some idea of the present day practice in illumination intensities recommended for the various departments of a Railroad Station:

AVERAGE INTENSITIES OF ILLUMINATION.

RAILROAD STATION LIGHTING.

Station approach	.25—1.00 foot candles
Waiting room	2— 3 foot candles
Baggage room	.5 —1.5 foot candles
Offices (General)	3— 5 foot candles
Offices (Private)	1— 3 foot candles
Dining rooms	2— 3 foot candles
Lunch rooms and counters	1— 3 foot candles

Train Sheds and Platforms

A general illumination is required of sufficient intensity to afford convenience to passengers in passing to and from the trains and to enable conductors and trainmen to inspect the tickets and also facilitate the handling of baggage.

Because of the prevailing high ceilings of train sheds, the lighting has been confined principally to the larger units such as arc lamps, however, since the development of the high efficiency incandescent lamp in large sizes we may expect a goodly share of this class of lighting to go to the incandescent lamps. In low ceiling sheds relatively small units located between tracks give better results from the standpoint of light distribution and consequent avoidance of shadows.

Freight House and Platform

The requirement for this class of lighting is low general illumination, sufficient to discharge or load and sort the various classes of freight. This may be accomplished best by incandescent lamps, the type of lamp being governed by the height of roof truss. In most cases the high efficiency incandescent Tungsten filament lamp will be found best adapted, and this should be equipped with suitable reflector and suspended close to the ceiling. For buildings with high ceilings where the lamps may be hung at a height sufficient to eliminate objectionable glare and also secure proper distribution the flame or luminous arc lamp may be used to good advantage. Where there are receiving and shipping desks or tables these can be lighted by means of drop lights, consisting of small candlepower lamps equipped with metal reflectors. These reflectors should be of such shape as to screen the lamp filament from the clerk's eyes.

The lighting of platforms is accomplished to best advantage by means of small candle-power incandescent lamps. These units should be equipped with metal reflectors and suspended either from wall bracket arms on the side of the shed or else from the roof where the platforms are covered by projecting eaves. The intensity of illumination required for this class of work is about the same as that necessary for the interior lighting of freight houses.

Incandescent Lamps

The incandescent lamp consists of a filament of refractory material in a vacuum enclosed by a glass globe. The filament is heated to incandescence by the electric current and so produces light. The essential features of the lamp besides the filament are the glass globe or bulb, the vacuum, the base and the leading-in wires.

Leading-in Wires:

The leading-in wires conduct the current into the bulb. It is essential that they be sealed into the glass so as to form an airtight joint. This is accomplished by the use

of platinum, which, when heated, expands at the same rate as glass.

Base:

The base serves both as a support and the electrical connection to the lamp. In the past quite a number of different styles of lamp bases were used, but now practically all lamps are provided with the so-called Edison base. This base consists of a metal shell having screw threads spun into it, which serves as one of the electric contacts and also holds the lamp in the socket. A central end cap forms the other contact and also serves as a stop when screwing the lamp in the socket.

shape of the bulb is to a certain extent, controlled by the filament to be enclosed. From the user's standpoint the size and shape of bulbs are important principally on account of the appearance of the lamps. On account of the limitations of glass manufacture, the standard forms of bulbs are cheaper and more readily obtained. They should be adhered to.

In the case of car lighting round bulb lamps almost invariably make the best appearance. This style is, therefore, most generally used and especially recommended for all classes of car lighting as far as possible. The standand forms of bulbs are illustrated in this report.

No. 101—Regular. No. 50—Candelabra. No. 601—Miniature. No. 401—Large Street Series. No. 101—Regular, with Brass Skirt.

STANDARD EDISON BASES.

Edison cases are made in four principal sizes, namely: No. 101 (regular), No. 50 (candelabra), No. 601 (minature), and No. 401 (large street series). The appearance and size of the bases are shown in the accompanying cut.

No. 101 (regular) applies to all kinds of railway car lamps except berth lighting and miniature decorative lamps which use No. 501 (candelabra) base. It should be noted that newer berth fixtures take No. 101 (regular) bases. Size No. 401 (large street series) is used with street series lamps and large size tungsten filament lamps. No. 401 and 601 have no application in car lighting.

In addition to the above No. 101 (regular) base is sometimes furnished with insulated brass skirt for some of the larger sizes of lamps. These bases are made with skirts of several different diameters of opening to correspond to the necks of larger bulbs. One of these bases is shown in the accompanying cut.

Vacuum.

The vacuum is a most important factor in the performance of the incandescent lamp. In order to obtain satisfactory results it is necessary not only to exclude the oxygen, but also all air or gas of any sort. It is readily understood that if the filament were heated to a high temperature in the presence of oxygen or air, combustion would take place and the filament be consumed. On the other hand, it is not so generally understood that the presence of even an inert gas would cool the filament by convection and thus reduce its efficiency. In the exhaustion of the lamp in actual manufacture the final traces of gas are removed by chemical processes.

Globe:

The globe or bulb serves not only to maintain the vacuum, but also to enclose the heated filament. In order to obtain the best results the size of the bulb should bear a proportionate relation to the capacity of the lamp so that proper radiation of the heat will be obtained. The

Lamps with frosted bulbs are sometimes used to diffuse the light. It is recommended, however, that this effect be obtained by means of external shades, rather than by frosting on the bulbs, which tends to shorten the normal life of lamps. Frosting also facilitates the accumulation of dirt and dust, which detracts from the appearance and efficiency of the lamps. Diffusion may be secured by the use of opal dip, which can easily be applied or removed by the user. In this connection it should be noted that reflectors can be more easily cleaned than the lamp bulbs.

From the customer's standpoint it is better to use as few styles of bulbs as possible, thereby obtaining the following advantages:

1. Interchangeability.
2. Small reserve stock necessary at distribution points.
3. Better deliveries and less chance of confusion in ordering.
4. Less chance of confusion or mixing shapes in lamping a car.

Filament:

The filament being the light source is of course the element of prime importance in the incandescent lamp. By varying the voltage impressed upon the filament we can change the temperature at which it is operated.

It is possible to impress such a voltage upon the filament that the resulting temperature will be below the point of incandescence so that the filament will give out no light and the efficiency be zero. Increasing the voltage, we can raise the temperature step by step through the point where a very faint reddish glow is given off and thus upward, increasing the volume of light and improving the efficiency and the color through yellow toward white.

Thus we find that high temperature of operation is advantageous both on account of the efficiency of the lamp and color of the light. On the other hand the higher the temperature at which a filament is operated, the more rapidly will it disintegrate and fail. Hence,

the most satisfactory operating condition for an incandescent filament is determined by a compromise between the cost of renewals on one side and the cost of energy and color of light on the other. From this it follows that where the price of power is high it may be better to run the filament at a higher efficiency than where the price of power is low. After years of experience with all classes of lighting the practice in this respect has become standardized.

Wherever there is a wide variation in the price of power three efficiencies have been adopted for each type of filament. The limitation of the filaments under these conditions are fully given under the heading of "Three Voltage Label" as explained later on in this report. With train lighting lamps, owing to the uniformity of practice but one voltage label is given.

Since the greatest opportunity of improvement in incandescent lamps lay in the production of filaments which would withstand high temperature for a long period of time, it is natural that the study of filament materials should have received a great deal of attention on the part of lamp manufacturers.

Carbon was the material originally used for lamp filaments. In the earliest lamps filaments were produced by carbonizing paper, bamboo fibre, silk or cotton thread. In the later lamps, the filaments have been made by dissolving cotton so as to form a structureless cellulose jelly. This mass is formed into a thread by squirting under pressure through a small opening. These threads are dried, formed into shape and carbonized. Later improvements in the process of manufacture have made it possible to secure purity of composition, density of structure, and uniformity of cross-section. This has been accomplished largely by the so-called flashing process in which a coating of graphitic carbon is deposited upon the purified carbonized thread. With these improvements the principal sizes of carbon incandescent lamps consume only 2.97 to 3.39 watts per mean horizontal candle-power, whereas the early lamps consumed as high as five or six watts per candle power.

Carbon has a fairly high specific resistance so that at ordinary voltages and capacities the filament is short and heavy as compared to metallic filaments. Carbon filaments do not soften when heated and in fact pass directly from the solid to the vapor state when raised to too high a temperature. Although carbon as a material will withstand a higher temperature than any other substance available, it is subject to a slow vaporization. This not only reduces the candle power by decreasing the size of the filament, but principally by condensation of the carbon vapor on the inner surface of the bulb. The coating thus formed absorbs an increasing amount of light with the aging of the lamp. The carbon filament lamp depreciates to a point where it is no longer profitable to operate it before the filament is broken or destroyed.

Carbon has a negative co-efficient of resistance, that is, the electrical resistance decreases as the temperature of the filament increases. This characteristic causes a more rapid change in temperature with any variation in voltage than would occur with a positive co-efficient or even constant resistance. On this account, therefore, the ordinary carbon filament is more affected in life and efficiency by variation of voltage than the Gem or any of the metallic filaments.

The Gem or metallized filament is a modification of the ordinary carbon filament, produced by further graphitizing processes utilizing the electric furnace.

The Gem filament is more refractory than the ordinary carbon, so that it is to run in practice at about 2.5 watts per mean horizontal candle power, or at 20 per cent higher efficiency. This filament has all of the advantages of the ordinary carbon with regard to strength, etc. Like metals, it has a positive resistance co-efficient so that the candle power and life are less affected by voltage variation.

Tantalum:

The metal tantalum is obtained commercially from columbite containing from 10 to 40 per cent of tantalum oxide. This oxide is separated from the other impurities in the ore by producing a fluoride from which metallic tantalum in the form of a black powder is obtained by reduction.

The refractory power of tantalum is high, the melting point being about 2,900 deg. C. The metal is tough and malleable. It can be beaten into thin sheets or drawn into fine wire. The tensile strength varies from 114,000 to 133,000 lbs. per sq. in. Oxidation takes place at high temperatures and the metal is not affected by ordinary reagents below a temperature of 300 deg. C. The tantalum filament consists of a wire of drawn tantalum which being more refractory than either the carbon or the gem filament is operated at two watts per mean horizontal candle power. Tantalum has a lower electrical resistance than carbon, so that the lamp filament is much longer and of smaller cross section for lamps of the same voltage and wattage. As tantalum becomes soft when heated it is supported on a special frame work which gives the lamp a peculiar appearance. When heated the filament is not so strong mechanically as the carbon. It has, however, a positive resistance co-efficient and is, therefore, less subject to candle-power and life variation with change of voltage. Owing to the crystalizing action of alternating current upon the material, the average life is considerably shorter on alternating current than on direct.

Tungsten:

Tungsten as a metal is obtained in a chemically pure state as a dark gray powder. The commercial process embodies the conversion of an oxide obtained from Wolframite, Scheelite or Hubernite into the metal, reducing it by heating in an atmosphere of hydrogen.

The refractory power of tungsten is very high, the melting point being about 3,100 deg. C. The superior efficiency of tungsten is due to the properties of remaining stable at high temperatures, and to its ability to emit more of its radiation in the visible spectrum.

The tungsten filament is least subject to slow evaporation and hence will stand a much higher operating temperature than either carbon or tantalum. It is, therefore, not only much better in color of light but produces under standard conditions two and one-half times as much light for the same energy as the most efficient of the ordinary carbon filaments. This gain in efficiency is so much higher than is ordinarily obtained within the same time of development, that it is very difficult to realize its magnitude and the effect upon the cost of lighting.

While tungsten filament lamps cost more than the carbon filament lamps, their use results in a great economy in light production.

Tungsten is of relatively low specific resistance so that a long slender filament is required. It becomes soft when heated and must be supported. It has a positive co-efficient of resistance higher than that of tantalum and is, therefore, even less affected in life and candle power by voltage variation. In some cases,

however, owing to the fineness of the filament and its resultant low heat capacity, it may show more flicker from low frequency alternating currents or rapid voltage variation. The tungsten filament can be used equally well on either direct or alternating currents, there being no difference in the life or performance of the lamp.

The first tungsten filaments were exceedingly brittle and fragile so that they were broken by a slight jar. Very extensive experimental improvements have been made from time to time so that today, although the filaments when cold are not yet as strong mechanically as the carbon, they are very much more rugged than the early product.

Tungsten filaments are made by several processes, most of which consist of forming powdered metal into a plastic mass with a suitable binder, squirting it into a thread, after which the binder is removed by electrochemical process, leaving the metallic tungsten. There are two principal methods of mounting filaments so made. For example, a filament may consist of several "hair-pin" sections separately mounted in series with each other, or a filament may be made up with a single thread strung on the supports similarly to the tantalum filament. When mounted according to the latter method, filaments are designated as "wire type." Another process of making tungsten filaments, which has recently been perfected, consists of forming the metallic tungsten into a bar and then drawing it out into a wire. A drawn wire filament is made in a single section strung on supports similarly to tantalum.

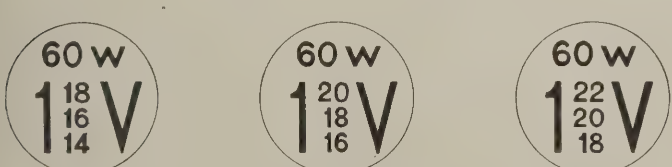
"Mazda" is a trade name which has been applied to tungsten filament lamps by a number of manufacturers who co-operate in research and engineering, to designate their most recent development in metal filament lamps.

Each of these types of filament have particular characteristics, the advantages of which have been advanced by their respective manufacturers. They constitute the commercial selling points of the lamps, and cannot properly be described in this report.

Method of Rating Incandescent Lamps:

While it is the practice to test lamps at the factories to one-fourth of 1 per cent of voltage, only integral voltages are used in commercial ratings. For example, 116 volts include 115¾, 116, 116¼, 116½. The candle power rating of lamps is being abandoned in favor of the wattage rating, which has the advantage of indicating the energy consumption of the lamp.

The three voltage method of labeling, 100 to 130 volts, employs, as its name indicates, three voltages on each label, as shown herewith:



Label for 60 watt lamp. high oper. effcy. on 118 volts.	Label for 60 watt lamp. med. oper. effcy. on 118 volts.	Label for 60 watt lamp. low op. effcy. on 118 volts.

These are known as the voltages for high, medium, and low operating efficiencies, respectively. This is a very flexible method of rating as it permits the lamps to be used at several efficiencies thereby adapting them to varying conditions of voltage regulation and power costs. To make this clear, as carbon lamps were rated in the past, a single lamp often appeared in the schedules as three separate lamps; for example, a 24 cp. 3.1 wpc. lamp was, with a reduction of 4 volts, a 20 cp. 3.5 wpc. lamp and at 4 volts still lower, it was a 16 cp. 4 wpc. lamp. Under the old method these three ratings would be shown by separate labels. It is evident that it would be simpler to place these three voltages on a single label. This is the idea employed in the three voltage method of labeling where each lamp bears a label having three voltages arranged in steps 2 volts apart in a vertical column as shown in the above sample labels.

At high operating efficiency the wattage appearing at the top of the label is consumed with maximum brilliancy and volume of light. The corresponding life and other performance data are given under the heading of High Operating Efficiency in the tables at the end of this report.

Similarly the voltages at the middle and at the bottom of the table correspond to medium and low operating efficiencies with correspondingly lower candle power and wattage, as well as longer burning life. It should be noted, however, that the reduction in candle power for medium and low efficiencies is greater than the falling off of the power consumed. These values are given under the medium and low efficiency headings in the tables.

The Most Economical Efficiency.

It will thus be seen that the three voltage method of labeling provides a method by which lamps can be operated at three efficiencies, thus enabling the consumer to employ them under the most satisfactory plan to suit any condition of service.

At the ordinary rates for current the cost of power consumed by an incandescent lamp is high compared to the cost of the lamp itself; if, therefore, the lamp is burned at too low an efficiency, the cost of power for a given amount of light will increase faster than the cost of renewals will decrease. In order to secure the lowest total cost of light in any case, we must ascertain the efficiency and life at which the lamp will give the lowest total cost of power plus lamp renewal cost. Where the cost of energy is high, the lamp may be operated at a relatively high efficiency. In this case the lamp life is shorter and the renewal cost higher, but the consumption of energy for a given amount of light is decreased. Where the cost of energy is low, the lamps may be operated at a lower efficiency thus increasing their life and decreasing their renewal costs. It is evident, therefore, that for every rate for power there is a corresponding efficiency at which the lamps can be operated and give a minimum lighting cost, including the cost of power and lamp renewals.

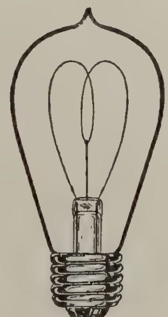
If the cost of lamps, plus cost of current be plotted in a curve, for varying efficiency it will be noted that the curve flattens as it approaches or leaves the point of minimum cost, so that there is a reasonably wide range of efficiencies through which the costs vary but little. This fortunate circumstance permits the economical use of lamps at standard efficiencies for all conditions, thus avoiding special or complicated determination of operating voltages.

Data on Lamps.

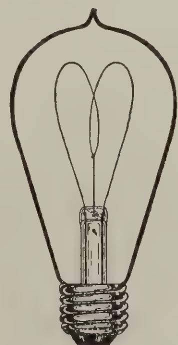
The appended tables give the principal performance and life values for the standard voltage ranges. Accompanying each of the tables are illustrations showing the appearance and general dimensions of the lamps.

C. R. Gilman, Chairman; Wm. D. A. Ryan, J. R. Cravath, S. W. Everett, C. W. Bender, B. F. Fisher, A. J. Sweet, T. R. Wentworth, Richard Hamilton.

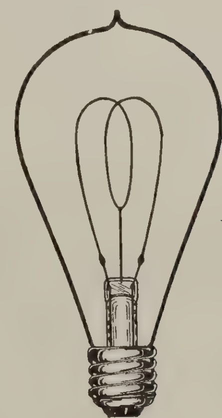
CARBON FILAMENT—LARGE STYLE—REGULAR TYPE 100 TO 130 VOLTS



Reg. S-17-A
20, 25 and 30 Watts



Reg. S-19-A
50 and 60 Watts

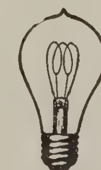


Reg. S-24-A
100 and 120 Watts

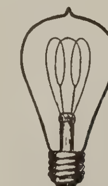
Rated Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watt	Average Watts	Candle-Power: Mean Horizontal	Candle-Power: Mean Spherical	Average Lumens	C.P. at 3.05 W.P.C.	Average Total Life in Hours	Stand. Pkg.: Quantity	Stand. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
20	Single	4.15	2.52	20.0	4.82	3.96	50.3	7.8	1500	200	31	S-17-A	2⅛	4⅜
25	High	3.10	3.34	25.0	8.07	6.68	83.6	8.3	500	200	31	S-17-A	2⅛	4⅜
	Medium	3.31	3.14	24.1	7.3	6.02	75.4		725					
	Low	3.52	2.94	23.2	6.6	5.44	68.2		1050					
30	High	3.23	3.20	30.0	9.29	7.67	96.4	10.2	1050	200	31	S-17-A	2⅛	4⅜
	Medium	3.46	3.00	28.9	8.4	6.93	87.0		1500					
	Low	3.69	2.81	27.8	7.5	6.18	77.7		2100					
50	High	2.97	3.49	50.0	16.83	13.85	174.0	16.1	700	200	36	S-19-A	2⅜	5
	Medium	3.18	3.26	48.2	15.2	12.55	158.0		1000					
	Low	3.39	3.06	46.4	13.7	11.30	142.0		1500					
60	High	2.97	3.49	60.0	20.20	16.57	208.0	19.4	700	200	36	S-19-A	2⅜	5
	Medium	3.18	3.26	57.9	18.3	15.10	190.0		1000					
	Low	3.39	3.06	55.7	16.4	13.52	170.0		1500					
100	High	2.97	3.49	100.0	33.66	27.7	349.0	32.2	600	100	28	S-24-A	3	5¾
	Medium	3.18	3.26	96.4	30.5	25.2	316.0		8[illegible]					
	Low	3.39	3.06	92.9	27.4	22.6	284.0		1350					
120	High	2.97	3.49	120.0	40.40	33.3	419.0	38.6	600	100	28	S-24-A	3	5¾
	Medium	3.18	3.26	115.8	36.5	30.2	379.0		850					
	Low	3.39	3.06	111.4	32.8	27.1	340.0		1350					

The spherical candle-power reduction factor that applies to the above table is 82.5 per cent.
Lamps of voltage for high efficiency rating will be shipped on all orders unless otherwise specified.

CARBON FILAMENT—LARGE STYLE—REGULAR TYPE 200 TO 275 VOLTS



Reg. P-19-A
35 Watts



Reg. P-21-A
60 Watts

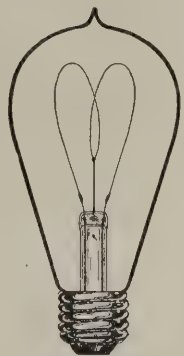
Reg. S-24-A
120 Watts

The filaments of these lamps are untreated because the required cross section is of such a small area that it will not permit of the necessary reduction to take on the hydro-carbon treatment.

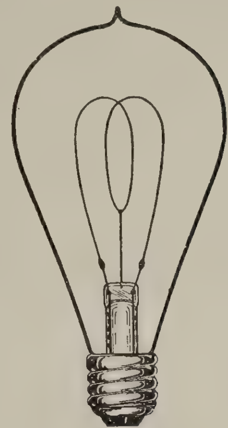
Rated and Average Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watt	Candle-Power: Mean Horizontal	Candle-Power: Mean Spherical	Average Lumens	C.P. at 3.05 W.P.C.	Average Total Life in Hours	Stand. Pkg.: Quantity	Stand. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
35	Single	4.40	2.40	7.95	6.68	84.0	13.7	1000	200	36	P-19-A	2⅜	4⅜
60	Single	3.69	2.84	16.26	13.6	171.0	21.6	750	200	40	P-21-A	2⅝	4⅞
120	Single	3.69	2.84	32.52	27.3	341.0	43.2	750	100	28	S-24-A	3	5¾

The spherical candle-power reduction factor that applies to the above table is 83.5 per cent.

GEM FILAMENT—LARGE STYLE—REGULAR TYPE 100 TO 130 VOLTS



S-19-A
40, 50 and 60 Watts

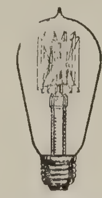


S-24-A
80 and 100 Watts

Rated Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watt	Average Watts	Candle-Power: Mean Horizontal	Candle-Power: Mean Spherical	Average Lumens	Average Total Life in Hours	Std. Pkg.: Quantity	Std. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
40	High	2.56	4.05	40.0	15.6	12.9	162	600	200	36	S-19-A	2⅜	5
	Medium	2.71	3.82	38.7	14.2	11.7	147	900					
	Low	2.89	3.59	37.3	12.9	10.6	134	1300					
50	High	2.50	4.15	50.0	20.00	16.5	207	700	200	36	S-19-A	2⅜	5
	Medium	2.65	3.91	48.4	18.3	15.1	189	1000					
	Low	2.81	3.69	46.7	16.6	13.7	172	1500					
60	High	2.50	4.15	60.0	24.00	19.8	249	700	200	36	S-19-A	2⅜	5
	Medium	2.65	3.91	58.0	21.9	18.1	227	1000					
	Low	2.81	3.69	56.0	19.9	16.4	207	1500					
80	High	2.46	4.21	80.0	32.52	26.8	337	700	100	28	S-24-A	3	5¾
	Medium	2.60	3.99	77.4	29.8	24.6	309	1000					
	Low	2.78	3.73	74.6	26.8	22.1	278	1500					
100	High	2.46	4.22	100.0	40.65	33.5	422	650	100	28	S-24-A	3	5¾
	Medium	2.60	3.99	96.7	37.2	30.7	386	950					
	Low	2.78	3.73	93.2	33.5	27.6	348	1400					

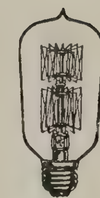
Spherical candle-power reduction factor 82.5 per cent.
Lamps of voltage for high efficiency rating will be shipped on all orders unless otherwise specified.

TANTALUM FILAMENT—LARGE STYLE—REGULAR TYPE 100 TO 125 AND 200 TO 250 VOLTS

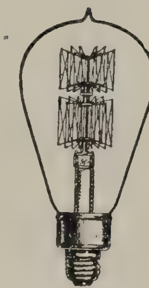


S-19-C
25, 40 and 50 Watts
100–125 Volts

S-24½-A
80 Watts
100 125 Volts



S-19-D
50 Watts
200–250 Volts

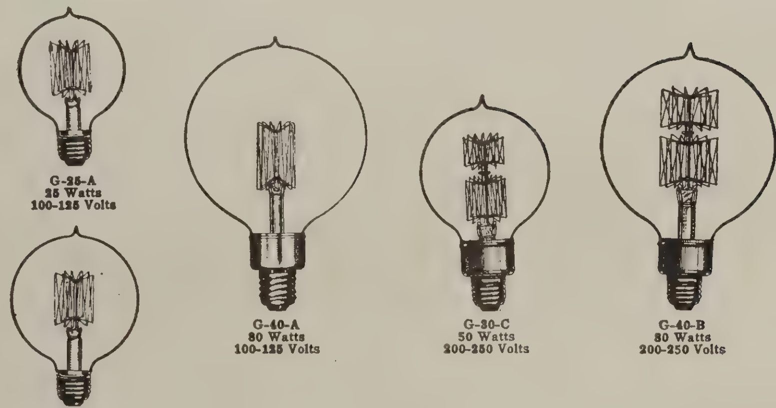


S-30-B
80 Watts
200–250 Volts

Rated Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watt	Average Watts	Candle-Power: Mean Horizontal	Candle-Power: Mean Spherical	Average Lumens	*Average Total Life in Hours On D.C.	Standard Package: Qty.	Standard Package: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
100 TO 125 VOLTS													
25	High	1.97	5.04	25.0	12.70	9.78	126	1000	100	30	S-19-C	2⅜	5
	Medium	2.05	4.83	24.2	11.8	9.08	117	1300					
	Low	2.14	4.64	23.5	11.0	8.47	109	1700					
40	High	1.79	5.54	40.0	22.35	17.2	221	800	100	30	S-19-C	2⅜	5
	Medium	1.87	5.31	38.8	20.7	15.9	206	1100					
	Low	1.95	5.09	37.6	19.3	14.9	191	1500					
50	High	1.79	5.54	50.0	27.93	21.5	277	800	100	30	S-19-C	2⅜	5⅜
	Medium	1.87	5.31	48.5	25.9	20.0	257	1100					
	Low	1.95	5.09	47.0	24.1	18.6	239	1500					
80	High	1.79	5.54	80.0	44.69	34.3	443	600	50	35	S-24½-A	3⅟₁₆	7⅛
	Medium	1.87	5.31	77.6	41.5	32.0	412	800					
	Low	1.95	5.09	75.2	38.6	29.7	383	1050					
200 TO 250 VOLTS													
50	Single	1.97	5.04	50.0	25.4	20.1	252.2	800	50	40	S-19-D	2⅜	5⁵⁄₁₆
80	Single	1.97	5.04	80.0	40.6	32.1	403.1	800	24	35	S-30-B	3¾	7¾

*These lamps are not recommended for alternating current service.
The spherical candle-power reduction factor that apply to the above table is 79 per cent.
Lamps of voltages for high efficiency rating will be shipped on all orders unless otherwise specified.

TANTALUM FILAMENT—LARGE STYLE—(IRREGULAR) ROUND BULB TYPE 100 TO 125 AND 200 TO 250 VOLTS



G-25-A 25 Watts 100-125 Volts
G-30-A 40 Watts 100-125 Volts
G-40-A 80 Watts 100-125 Volts
G-30-C 50 Watts 200-250 Volts
G-40-B 80 Watts 200-250 Volts

Rated Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watt	Average Watts	Candle-Power: Mean Horizontal	Candle-Power: Mean Spherical	Average Lumens	* Average Total Life in Hours: On D.C.	Std. Pkg.: Quantity	Std. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
100 TO 125 VOLTS													
†25	High	1.97	5.04	25.0	12.7	9.78	126	1000					
	Medium	2.05	4.83	24.2	11.8	9.08	117	1300	50	24	G-25-A	3⅛	4¾
	Low	2.14	4.64	23.5	11.0	8.47	109	1700					
‡40	High	1.79	5.54	40.0	22.3	17.2	221	800					
	Medium	1.87	5.31	38.8	20.7	15.9	206	1100	24	22	G-30-A	3¾	6¼
	Low	1.95	5.09	37.6	19.3	14.9	191	1500					
**80	High	1.79	5.54	80.0	44.6	34.3	443	600					
	Medium	1.87	5.31	77.6	41.5	32.0	412	800	24	28	G-40-A	5	7¾
	Low	1.95	5.09	75.2	38.6	29.7	383	1050					
200 TO 250 VOLTS													
**50	Single	1.97	5.04	50.0	25.4	20.1	252	800	24	22	G-30-C	3¾	6¼
**80	Single	1.97	5.04	80.0	40.6	32.1	403	800	24	28	G-40-B	5	7¾

*These lamps not recommended for alternating current service.

†This lamp regularly supplied with regular standard base (unskirted) only.

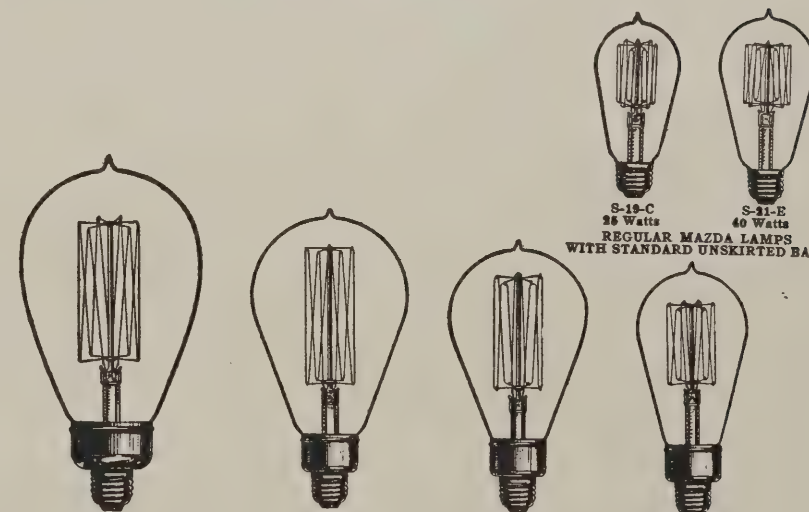
‡Regularly supplied with regular standard base (unskirted). (May be supplied with skirted base at an additional charge when specially ordered.)

**Regularly fitted with standard skirted base only.

The spherical candle-power reduction factor that applies to the above table is 79 per cent.

Lamps of voltage for high efficiency rating will be shipped on all orders unless otherwise specified.

TUNGSTEN FILAMENT—LARGE STYLE—REGULAR TYPE 100 TO 125 VOLTS



S-19-C 25 Watts
S-21-E 40 Watts
REGULAR MAZDA LAMPS WITH STANDARD UNSKIRTED BASE
S-40-B 250 Watts
S-35-A 150 Watts
S-30-A 100 Watts
S-24 1/2-A 60 Watts

Rated Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watt	Average Watts per Lamp	Candle-Power: Mean Horizontal	Candle-Power: Mean Spherical	Average Lumens	Average Total Life in Hours	Std. Pkg.: Quantity	Std. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
25	High	1.31	7.58	25.0	19.08	15.1	189	1000					
	Medium	1.37	7.25	24.2	17.7	14.0	175	1300	100	55	S-19-C	2⅜	5⅛
	Low	1.43	6.94	23.4	16.4	12.9	162	1700					
40	High	1.23	8.07	40.0	32.52	25.7	323	1000					
	Medium	1.28	7.76	38.9	30.4	24.0	302	1300	100*	56	S-21-E	2⅛	5⅝
	Low	1.33	7.47	37.8	28.5	22.5	282	1700	50*	40	S-21-C	2⅜	6¾
60	High	1.18	8.42	60.0	50.81	40.1	505	1000					
	Medium	1.23	8.07	58.2	47.3	37.4	470	1300	50	47	S-24½-A	3 1/16	7
	Low	1.28	7.76	56.5	44.2	34.9	438	1700					
100	High	1.18	8.42	100.0	84.68	66.9	842	1000					
	Medium	1.23	8.07	97.0	78.9	62.3	783	1300	24	43	S-30-A	3¾	7⅝
	Low	1.28	7.76	94.2	73.6	58.1	731	1700					
150	High	1.18	8.42	150.0	127.0	100.4	1262	1000					
	Medium	1.23	8.07	145.5	118.3	93.5	1170	1300	24	54	S-35-A	4⅜	8⅝
	Low	1.28	7.76	141.2	110.4	87.2	1095	1700					
250	High	1.13	8.79	250.0	221.23	175.5	2195	1000					
	Medium	1.18	8.42	242.0	204.2	161.5	2035	1300	12	46	S-40-B	5	9⅝
	Low	1.23	8.07	235.0	191.0	151.0	1895	1700					

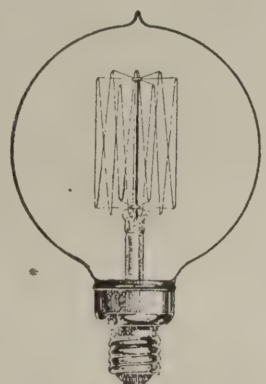
* Values on line from here to right cover the two 40 watt regular lamps. The top row is for the 40 watt small bulb lamp fitted with regular Edison unskirted base and the bottom row for the 40 watt skirted base lamp.

The regular lamps are supplied clear unless otherwise specified.

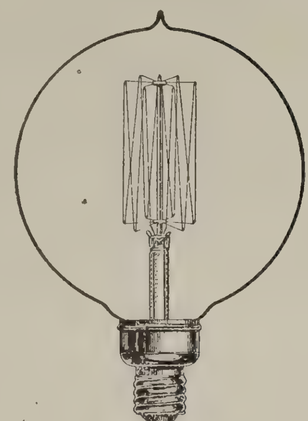
Bowl frosted lamps are recommended for general use.

The spherical reduction factor that applies to the above table is 79 per cent.

TUNGSTEN FILAMENT—LARGE STYLE—IRREGU-LAR) ROUND BULB TYPE 100 TO 125 AND 200 TO 250 VOLTS—400 TO 500 WATTS



G-56-A
400 WATT
100-125 VOLT



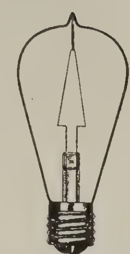
G-64-A
500 WATT
100-125 VOLT

Rated Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watts	Average Watts per Lamp	Candle-Power: Mean Horizontal	Candle-Power: Mean Spherical	Average Lumens	Average Total Life in Hours	Std. Pkg.: Qty.	Std. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
					100 TO 125 VOLTS								
400	High Medium Low	1.13 1.18 1.23	8.79 8.42 8.07	400 387 376	354 328 306	280 259 242	3512 3254 3034	1000 1300 1700	8	48	G-56-A	7	10½
500	High Medium Low	1.13 1.18 1.23	8.79 8.42 8.07	500 484 470	442 410 382	349 324 302	4390 4070 3793	1000 1300 1700	8	50	G-64-A	8	11½
					200 TO 250 VOLTS								
500	Single	1.23	8.07	500	407	321.5	4035	1000	8	50	G-64-A	8	11½

The spherical candle-power reduction factor that applies to the above table is 79 per cent.

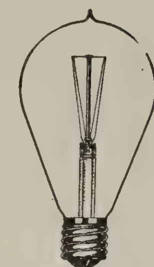
*Standard base can be supplied when specially ordered but is not recommended.

TUNGSTEN FILAMENT—STREET SERIES STYLE—REGULAR TYPE

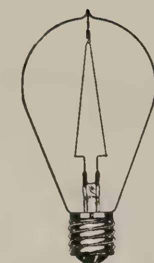


S-27 1/2-A
32 and 40 C-P.
3.5, 4, 5.5, 6.6 and 7.5 Amps.
60 C-P.
5.5, 6.6 and 7.5 Amps.

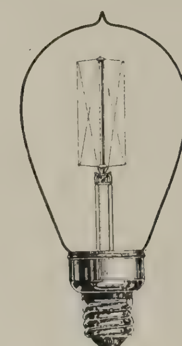
S-27 1/2-A
60 C-P.
3.5 and 4 Amps.



S-35-A
80 C-P.
3.5, 4 and 5.5 Amps.
100 C-P.
4, 5.5 and 6.6 Amps.



S-35-A
80 C-P. 6.6 Amps.
80 and 100 C-P. 7.5 Amps.



S-40-A
200 C-P.
5.5, 6.6 and 7.5 Amps.

Fitted with Large Street Series Base*

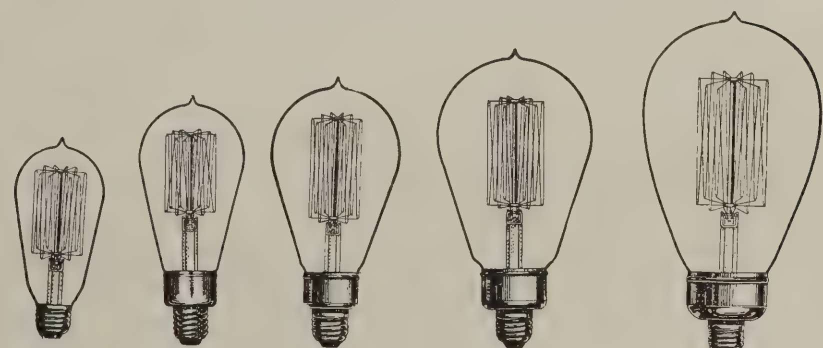
Ampere Range	Candle-Power: Rated Mean Horiz	Candle-Power: Mean Spher.	Average Lumens	Lumens per Watt	Average Volts per Lamp	Average Total Life in Hrs.	Style of Filament	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
3.5 (3.0 to 3.8)	32 40 60 80	25.0 31.6 47.0 62.6	314 394 591 788	8.34	10.9 13.5 20.1 27.0	1350	1 loop 1 loop 2 loops 2 loops	S-27½-A S-27½-A S-27½-A S-35 -A	3 7/16 3 7/16 3 7/16 4⅜	7¼ 7¼ 7¼ 8¼
4.0 (3.8 to 4.3)	32 40 60 80 100 200 350	25.0 31.6 47.0 62.6 78.3 156.6 274.1	314 394 591 788 984 1970 3445	8.34	9.5 11.8 17.8 23.6 29.5 59.0 103.3	1350	1 loop 1 loop 2 loops 2 loops 2 loops 4 loops 6 loops	S-27½-A S-27½-A S-27½-A S-35 -A S-35 -A S-40 -A G-64 -A	3 7/16 3 7/16 3 7/16 4⅜ 4⅜ 5 8	7¼ 7¼ 7¼ 8¼ 8¼ 10⅛ 11¾
5.5 (5.1 to 5.9)	32 40 60 80 100 200 350	25.0 31.6 47.0 62.6 78.3 156.6 274.1	314 394 591 788 984 1970 3445	8.34	6.9 8.6 12.9 17.2 21.4 42.9 75.0	1350	1 loop 1 loop 1 loop 2 loops 2 loops 3 loops 5 loops	S-27½-A S-27½-A S-27½-A S-35 -A S-35 -A S-40 -A G-64 -A	3 7/16 3 7/16 3 7/16 4⅜ 4⅜ 5 8	7¼ 7¼ 7¼ 8¼ 8¼ 10⅛ 11¾
6.6 (6.1 to 6.9)	32 40 60 80 100 200 350	25.0 31.6 47.0 62.6 78.3 156.6 274.1	314 394 591 788 984 1970 3445	8.34	5.8 7.2 10.8 14.3 17.9 35.8 62.6	1350	1 loop 1 loop 1 loop 1 loop 2 loops 3 loops 5 loops	S-27½-A S-27½-A S-27½-A S-35 -A S-35 -A S-40 -A G-64 -A	3 7/16 3 7/16 3 7/16 4⅜ 4⅜ 5 8	7¼ 7¼ 7¼ 8¼ 8¼ 10⅛ 11¾
7.5 (7.0 to 8.0)	32 40 60 80 200	25.0 31.6 47.0 62.6 156.6	314 394 591 788 1970	8.34	5.1 6.3 9.5 12.6 31.5	1350	1 loop 1 loop 1 loop 1 loop 3 loops	S-27½-A S-27½-A S-27½-A S-35 -A S-40 -A	3 7/16 3 7/16 3 7/16 4⅜ 5	7¼ 7¼ 7¼ 8¼ 10⅛

Spherical reduction factor for the above table is 78.3 per cent.

Standard package: 32, 40 and 60 candle-power, 50 lamps and weight 50 pounds. 80 and 100 candle-power, 24 lamps and weight 55 pounds. 200 candle-power, 12 lamps and weight 45 pounds. 350 candle-power, 8 lamps and weight 46 pounds.

* Regular standard base supplied at same price.

TUNGSTEN FILAMENT—LARGE STYLE—REGULAR TYPE 200 TO 250 VOLTS



S-21-D 40 Watt — S-24 1/2-B 60 Watt — S-30-B 100 Watt — S-35-A 150 Watt — S-40-B 250 Watt

Rated and Average Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watt	Candle-Power: Mean Hori-zontal	Candle-Power: Mean Spher-ical	Average Lumens	Average Total Life in Hours	Std. Pkg.: Quan-tity	Std. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
40 *	Single	1.31	7.58	30.5	24.1	303	1000	50	46	S-21-D	2⅝	5½ † / 6¾ ‡
60	Single	1.31	7.58	45.8	36.2	455	1000	50	40	S-24½-B	3 1/16	7
100	Single	1.31	7.58	76.4	59.8	758	1000	24	43	S-30-B	3¾	7¾
150	Single	1.31	7.58	114.5	90.4	1137	1000	24	46	S-35-A	4⅛	8⅜
250	Single	1.31	7.58	190.8	150.8	1895	1000	12	46	S-40-B	5	9⅝

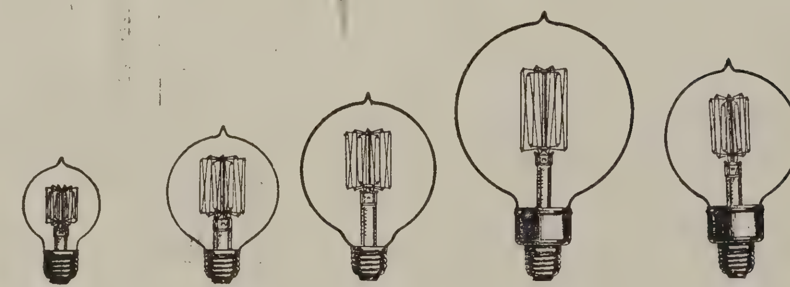
For the above table the spherical reduction factor is 79 per cent.

* The 40 watt lamp is now made with the standard base without skirt. This unskirted base lamp will regularly be supplied unless order specifies otherwise.

† Regular standard base without skirt.

‡ Large bulb with standard skirted base.

TUNGSTEN FILAMENT—LARGE STYLE—(IRREGULAR) ROUND BULB TYPE 100 TO 125 AND 200 TO 250 VOLTS



G-18½ 25 watts 100-125 volts — G-25-C 25 watts 100-125 volts — G-30-C 40 watts 100-125 volts — G-40-A 60 watts 100-125 volts — G-30-D 40 watts 200-250 volts

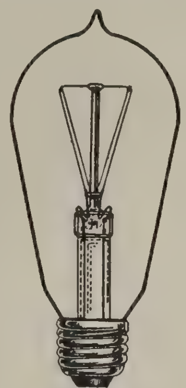
Rated Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watts	Average Watts per Lamp	Candle-Power: Mean Hori-zontal	Candle-Power: Mean Spher-ical	Average Lumens	Average Total Life in Hours	Std. Pkg.: Quan-tity	Std. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
100 TO 125 VOLTS													
†25	High	1.31	7.58	25.0	19.1	15.1	189	1000	100	35	G-18½	2 5/16	3½
	Medium	1.37	7.25	24.2	17.7	14.0	175	1300	50	36	G-25-C	3⅛	4⅝
	Low	1.43	6.94	23.4	16.4	12.9	162	1700					
§40	High	1.23	8.07	40.0	32.5	25.7	323	1000	24	44	G-30-C	3¾	6
	Medium	1.28	7.76	38.9	30.4	24.0	302	1300					
	Low	1.33	7.47	37.8	28.5	22.5	282	1700					
‡60	High	1.18	8.42	60.0	50.8	40.1	505	1000	24	50	G-40-A	5	7⅝
	Medium	1.23	8.07	58.2	47.3	37.4	470	1300					
	Low	1.28	7.76	56.5	44.2	34.9	438	1700					
200 TO 250 VOLTS													
‡40	Single	1.31	7.58	40.0	30.5	24.1	303	1000	24	44	G-30-D	3¾	6
‡60	Single	1.31	7.58	60.0	45.8	36.3	455	1000	24	50	G-40-B	5	7⅝

†Standard base without skirt. ‡Fitted with Standard skirted base only.

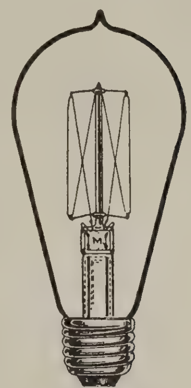
§May be supplied with Standard skirted base at a small additional charge.

The spherical reduction factor that applies to the above table is 79 per cent.

TUNGSTEN FILAMENT—LARGE STYLE—COMPENSATOR TYPE 25 TO 34 AND 57 TO 65 VOLTS



S-19 Bulb
10, 15, 20, 25 and 40 Watts
25 to 34 Volts



S-19 Bulb
15, 20, 25 and 40 Watts
57 to 65 Volts

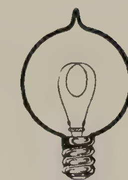
FOR USE WITH REDUCING TRANSFORMERS

Rated and Average Watts	Efficiency			Candle-Power		Average Lumens	Average Total Life in Hours	Style of Filament	Bulb		Length Over All in In.
	Rating	W.P.C.	Lumens per Watt	Mean Horizontal	Mean Spherical				Style	Diam. in In.	
					25 TO 34 VOLTS						
10	Single	1.23	8.28	8.1	6.6	82.8	1000	2 loop	S-19	2⅜	5¼
15	Single	1.23	8.28	12.2	9.9	124	1000	2 loop	S-19	2⅜	5¼
20	Single	1.23	8.28	16.3	13.2	166	1000	2 loop	S-19	2⅜	5¼
25	Single	1.23	8.28	20.3	16.5	207	1000	2 loop	S-19	2⅜	5¼
40	Single	1.23	8.28	32.5	26.4	331	1000	2 loop	S-19	2⅜	5¼
50	Single	1.23	8.28	40.7	32.9	414	1000	3 loop	S-21	2⅝	5⅜
					57 TO 65 VOLTS						
15	Single	1.23	8.28	12.2	9.9	124	1000	3 loop	S-19	2⅜	5¼
20	Single	1.23	8.28	16.3	13.2	166	1000	3 loop	S-19	2⅜	5¼
25	Single	1.23	8.28	20.3	16.5	207	1000	3 loop	S-19	2⅜	5¼
40	Single	1.23	8.28	32.5	26.4	331	1000	4 loop	S-19	2⅜	5¼
50	Single	1.23	8.28	40.7	32.9	414	1000	4 loop	S-21	2⅝	5⅜

Bowl frosted lamps are recommended for general use.
Standard package quantity, 100 lamps; weight, 27 to 30 pounds.
The spherical reduction factor that applies to the above table is 81 per cent.

GEM FILAMENT—MISCELLANEOUS STYLE—TRAIN LIGHTNING TYPE 28 TO 34 AND 57 TO 65 VOLTS

G-12-A
20 Watts
57 to 65 Volts
Berth Light



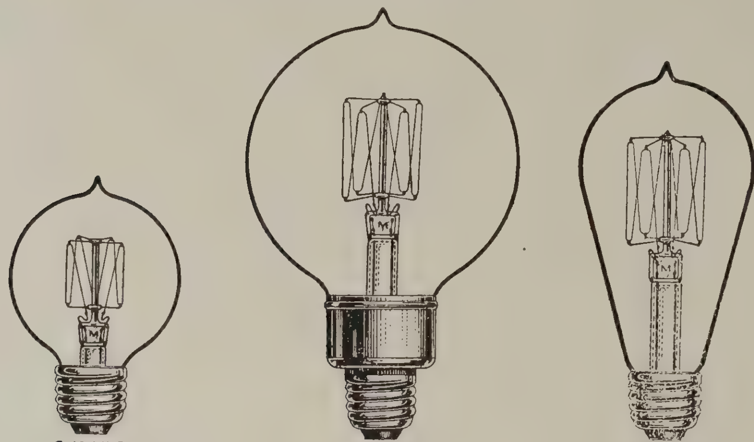
G-12-A
15 Watts
28 to 34 Volts
Berth Light

Bulbs will be frosted or opal dipped if desired but the plain bulb tipped lamp is standard.

Type	Rated and Average Watts	Efficiency			Candle-Power		Average Lumens	Average Total Life in Hrs.	Standard Pkg.		Bulb		Length Over All in In.
		Rating	W.P.C.	Lumens per Watt	Mean Horizontal	Mean Spherical			Quantity	Wt. in Lb.	Style	Diam. in In.	
						28 TO 34 VOLTS							
Berth Lt.	15.0	Single	2.46	4.32	6.1	5.2	64.8	300	200	30	G-12-A	1½	2⅝
						57 TO 65 VOLTS							
Berth Lt.	20.0	Single	2.46	4.32	8.1	6.9	86.4	300	200	30	G-12-A	1½	2⅝

The spherical reduction factor applying to the above table is 84.5 per cent.

TUNGSTEN FILAMENT—MISCELLANEOUS STYLE— TRAIN LIGHTNING TYPE 25 TO 34 AND 57 TO 65 VOLTS



G-18 1/2-B
15 & 25 Watts
57 to 65 Volts

G-30-B
50 Watts
57 to 65 Volts

S-19-B
20, 25 & 40 Watts
57 to 65 Volts

The round bulb type of lamp is the preferred standard for train lighting service. Tipped lamps in clear bulbs are standard.

Type	Rated Watts	Efficiency: Rating	Efficiency: W.P.C.	Efficiency: Lumens per Watt	Average Watts	Candle-Power: Mean Horizontal	Candle-Power: Mean Spherical	Average Lumens	Average Total Life in Hrs.	Style Filament	Std. Pkg.: Quantity	Std. Pkg.: Wt. in Lb.	Bulb: Style	Bulb: Diam. in In.	Length Over All in In.
25 TO 34 VOLTS															
Regular	15	Single	1.23	8.28	15	12.2	9.9	124	1000	2 loop	100	58	S-19-B	2⅜	5¼
	25		1.23	8.28	25	20.3	16.2	207	1000	2 loop					
	40		1.23	8.28	40	32.5	25.9	331	1000	2 loop					
Round Bulb	15		1.23	8.28	15	12.2	9.9	124	1000	3 loop	100	26	G-18½-B	2 5/16	3½
	25		1.23	8.28	25	20.3	16.2	207	1000	4 loop					
	50		1.23	8.28	50	40.7	32.4	414	1000	3 loop	24	43	G-30-B	3¾	6
57 TO 65 VOLTS															
Regular	20	Single	1.23	8.28	20	16.25	13.2	166	1000	3 loop	100	58	S-19-B	2⅜	5¼
	25		1.23	8.28	25	20.3	16.2	207	1000	3 loop					
	40		1.23	8.28	40	32.5	25.9	331	1000	4 loop					
Round Bulb	15		1.23	8.28	15	12.2	9.9	124	1000	4 loop	100	26	G-18½-B	2 5/16	3½
	25		1.23	8.28	25	20.3	16.2	207	1000	4 loop					
	50		1.23	8.28	50	40.7	32.4	414	1000	4 loop	24	43	G-30-B	3¾	6

†Can be supplied in a longer base which will allow their use in sockets with long husks.
Spherical reduction factor 81 per cent.

Report of Committee on Improvements

The improvements mentioned in this report are improvements in means rather than in methods They have been secured by canvassing the manufacturers making electrical goods for the railways. All the improvements noted have been brought out since October, 1910.

In listing the improvements, the following classification has been observed:

1. Axle lighting equipment.
2. Storage batteries.
3. Lamps, shades and fixtures.
4. Fans.
5. Motors and generators.
6. Controlling devices.
7. Wires and wiring devices.
8. Transformers, rectifiers, etc.
9. Instruments.
10. Miscellaneous.

I.—AXLE LIGHTING EQUIPMENT.

The Consolidated Railway Electric Lighting & Equipment Company has developed a new regulator, known as the "Type L" regulator. The action of this regulator varies the resistance in the circuits by means of a rocking contact operated by a plunger electro-magnet. The rheostats are composed of separate grids, insulated from each other.

The lamp regulator is in a separate case with the magnet mounted outside the case. This magnet is of the iron-clad type, wound with wire of zero temperature coefficient. It is provided with an air dashpot. The moving parts are the magnet core, rocking shoe and balancing spring. This spring acts against the curved surface of a cam, producing a changeable abutment for the spring, which varies the tension of the spring in direct proportion to the magnetic pull of the core, thereby balancing the rocker contact shoe through its motion.

The field regulator is the same in principle as the lamp regulator but is provided with an oil dashpot instead of an air dashpot. It is mounted on the panel which holds the rest of the generator control apparatus. It is provided with a dust proof cover.

During the past year the Gould Coupler Company has placed on the market a new system of Electric Car Lighting Control called the "Simplex System."

This system differs radically from their previous systems in that the control of the generator is a combination of mechanical and electrical control. The control formerly used was electrical and based on the bucking affect of an auxiliary generator connected in series with the field coils of the dynamo. The electrical pole changer of the previous system is replaced by a mechanical pole changer mounted directly on the commutator end housing and correcting for reversal of car direction on the first revolution of the dynamo armature.

The mechanical pole changer consists of a double pole double throw switch, the throw of which is actuated by a small dog carried in a retainer which is mounted directly on the dynamo armature shaft.

The control of the generator output under all conditions is electrical and is obtained through the variable compression of a single carbon pile, which is connected in series with the dynamo field. The resistance in the carbon pile is varied through the movement of two levers, one of which is actuated by the plunger of a solenoid, through the coil of which passes all current from the generator to the battery, thus regulating the battery charging rate. The other lever is actuated by the plunger of a solenoid, the coil of which is placed across the generator terminals, thus providing potential regulation when batteries have become fully charged or in case of an "open" in the battery circuit. These panels are furnished in two types, one regulating for a constant output of the generator, the other regulating for a given current charge to the batteries and carrying the lamp load independently.

The automatic switch on this panel is the same as used previously with the addition of a small set of laminated copper brushes placed at the top of the switch. Contact across these is made by a brass disc when the solenoid switch drops open, thus shorting the series solenoid coil in the battery charging circuit.

The dynamo is of the usual shunt type, the only radical departures thereon being in the oil wells of the housings. These oil wells are waste packed; but are provided with ribs on the bottom and sides, the former terminating in prongs directly in front of hand hole, which insures the holding up of the waste against the shaft. The ribs on the bottom permit a free passage of oil to all parts of the oil well. The inspection hand hole is provided with a hinged felt gasketed cover, securely held in the closed position by a steel spring, which also holds the cover up when opened.

The lamp voltage regulator is the same as employed in their previous systems.

The Safety Car Heating and Lighting Company reports the following improvements:

In place of the pilot with its pile of carbons in series with the magnet of the lamp regulator, a simple relay has been substituted. This relay consists of a solenoid, the winding of which carries the lamp voltage. It is provided with three resistances.

This type of lamp regulator is considerably simpler than the former type inasmuch as the relay used is simpler in construction than the carbon pilot and does the work equally well. It does away with one carbon pile and the dashpot which the use of this pile requires. The relay has been thoroughly tried out and has given excellent satisfaction.

A new suspension has been developed. In this suspension the main supporting bars are fastened either to the wheel guard of the truck or to the outside frame. In the latter case the suspension bar is passed through an opening in the end of the truck which is now being provided on all steel trucks, and bolted fast to the outer member of the truck. The generator is supported on two round steel bars which are passed through lugs cast on the frame of the generator. Bolted to the ends of these bars are four links which are carried by the main supporting member of the suspension through a saddle resting on the top of the main supporting bar. Each of these saddles has two side members which pass down over the supporting bar, and are secured to it by bolts. The bolt holes of the saddle are slotted to permit their being moved for aligning the generator. The supporting links are bolted to this saddle in such a way that the links are free to rotate.

The saddle has a projection to which the aligning bolts are fastened. The other end of the aligning bolt passes through a bracket on the main supporting bar. This main supporting bar is bent down as shown in order to take the angle iron which carries the tension spring. But one tension spring is used and this is placed in such a position that it comes in direct line with the belt pull.

The United States Light and Heating Company has made the following improvements in their axle lighting equipment.

1. A flexible hand hole cover has been perfected and put in service.
2. A new stop charge relay has been developed, is being manufactured and will very shortly be put in service.
3. A short-circuiting device has been developed for the lamp regulator. It is now in process of manufacture.
4. The Type H Relay has been improved by substituting solid bars for two parallel springs which supported the lower carbon contact.
5. A ring chain oiler has been developed and over 100 put into service.
6. Generator heads have been redesigned so as not to extend above the generator frame casting, thus securing clearance of all generator parts beneath the car under frame.
7. A new terminal box has been perfected for the generator and put into service.
8. The terminal block on the lamp regulator has been put into service, although the same was developed previous to October, 1910.
9. Pilot lamps have been removed from all panels and two terminal posts substituted therefor, thus permitting the pilot lamp to be located outside in the passageway of the car where it can be seen by train men.
10. A new suspension link has been devised to eliminate the necessity of furnishing adapters with M-3 generators on wood cars. The link has been otherwise redesigned so as to reduce the possibility of any breakage at the points where the link is bent.
11. A case hardened bushing, to be used in the eye of the suspension link, has been developed and will undoubtedly be put into service before long.
12. A tension limiting device has been developed, whereby the tension on the tension spring can be absolutely fixed, but has not been put into service.

13. Continuous foot caps for the generators have been developed, thus enormously strengthening the fastenings to the links and eliminating the possibility of generators falling off the suspension.

Axle Pulleys.

The American Pulley Company has designed an independent malleable bushing which clamps on the axle and furnishes a straight seat for the pulley. The clamping bolts are made with castellated nuts and drilled for a cotter pin. Instead of a straight seat there is a lug which engages in a hole in the pulley hub. This prevents the pulley from slipping on the hub.

The Oneida Steel Pulley Co. is building a new pulley called the Keystone R. R. pulley, in which the rim is built of 3-16 inch stock. This company has also developed a corrugated bushing, shown in the accompanying illustration. The advantages claimed for this bushing are lightness and better grip on the axle. It is built either to clamp to the axle or in short lengths held in place by the compression of the pulley.

Belts.

The New York Leather Belting Company has a new belt known by the trade name "Axonelat," made of 40 oz. duck instead of 32 oz. as has heretofore been used, and having correspondingly greater strength and durability.

Belt Fasteners.

The Crescent Belt Fastener Co. have changed their plates so that they have turned up edges which permit free movement of the belt when leaving the pulley.

Other Auxiliaries.

The Oliver Electric & Mfg. Co., has designed a new Solenoid Automatic Switch. The top of the plunger is connected to a lever arm by an insulated link. One end of the lever arm is pivoted and the other carries the copper and carbon contact. A full break of ½-in. is provided. The lower end of the plunger is furnished with a steel armature which is adjustable to provide a working range of voltage.

The Delta-Star Electric Co. has made improvements in their train connectors by putting an extra insulating plate on the back to afford additional protection when using these with steel cars, and have also improved the quality of them by polishing all parts in order to get better contact and to improve the appearance externally. Several small details of the internal arrangement have also been modified and in various ways these connectors have been changed as indicated by experience. This company has also developed a new type of connector for extension circuits. This has a maximum capacity of 50 amperes at 125 volts and is a double pole connector. The receptacle is mounted in an iron box with a cover. The plug is arranged so that it is held in by means of a spring contact, but will readily slip out in case the car or other apparatus on which it is used should be moved away without disconnecting.

II. STORAGE BATTERIES.

The Edison Storage Battery Co. has made the following improvements on their battery:

The steel container for car lighting cells is now made 3 inches higher, thus permitting 3½-in. of electrolyte above the top of the plates. This decreases the number of times that water must be added to the batteries. Heavier rubber insulation has been provided within the cell. The container is now made of heavier steel with more corrugations and is proportionately stronger.

The Niagara Lead & Battery Co. has, during the past year placed on the market the Salom battery.

This battery is made by filling antimonial lead grids with spongy lead for the negative plate, and peroxide of lead for the positive plate. These materials are formed in electrolytic cells which insures absolute chemical purity and are put into the plates under great pressure. It is claimed that the plate becomes thoroughly homogeneous and will not swell or shrink in service.

This company is also furnishing small lighting equipments consisting of 1 h. p. gasoline engine, small d. c. 30 volt dynamo, and a battery of 15 cells adapted to lighting of isolated railway stations.

Oneida Corrugated Bushing.

U. S. Light & Heating Company reports the following improvements in their "National" Battery:

1. The ribbing of the negative plate has been changed from .022″ space and .018″ rib, to .026″ space and .018″ rib. This was done to increase and retain the capacity of the Negative Plates.

2. The ribbing of the Positive Plates has been changed from .022″ space and .018″ rib to .018″ space and .022″ rib. This was done to prevent the active material from falling out and to increase the amount of reserve lead in the plate so as to lengthen the life of the Positive Plate.

3. We have also eliminated the lead-burning of the plates to the straps and we are now moulding the plate straps to the plate lugs by a method of superheated lead moulding which gives much better results, also makes a better fillet at the intersection of the plate strap and the plate plug.

4. We have designed a positive and negative post strap bearing the positive and negative sign respectively.

5. We have also put a rib on both outside edges of the separators to prevent breaking the edges of same and to eliminate any possibility of the negative and positive plates coming in contact and short circuiting the cell.

The Willard Storage Battery Co. reports that they are making their positive plates smaller than the negative to provide for the increase in size while in service. They are using the lead cover instead of the rubber cover, and in some cases having it burnt to the cover frame making a perfectly tight joint, thus doing away with all slopping of electrolyte.

A new vent plug containing a number of large holes has been devised. This plug is made in such a way that the spray is separated from the gases before the gases escape.

The Oliver Electric & Mfg. Co. has developed a flexible connector for car lighting battery consisting of a flexible stranded No. 4 B. & S. copper cable entirely covered by a seamless lead coating. The lead is stripped back from the ends of the cable 1 inch. These are connected to a 5/16″ brass bolts. Antimonial lead is molded over the square head of the bolt. This lead forms the faces of the connector terminals.

The nut used with this connector is of brass embedded in antimonial lead. The connector is wrapped with an acid resisting and insulating tape.

To avoid possibility of accident due to explosion of gas in storage batteries your committee recommends that all men handling storage batteries after the covers have been sealed in, be provided with heavy automobile goggles.

III. LAMPS, SHADES AND FIXTURES.

National Electric Lamp Association reports as follows on the developments in incandescent lamps during the past year:

The carbon, gem and tantalum lamps are not essentially different from those manufactured a year or so ago. There is, however, a gradual improvement in quality due to increased knowledge and experience on the part of the manufacturer. The most important development has been the placing upon the open market of the lamp having a filament of drawn tungsten wire. This is sold under the name of "Mazda," the trade name formerly applied to the pressed filament lamp.

The wire used for filaments in these lamps is made from the pure metal, the ingot being worked into bar shape and then worked down to the small size necessary for lamps. The finishing processes consist of drawing through diamond dies of the necessary fineness. The wire obtained is tough and uniform and may be placed in the lamp in one piece by winding on a support similar to that used in tantalum lamps. The advantages of the new lamp are those arising from the fact that the new filament resists breaking better than the old and the fact that the entire filament is continuous.

The ruggedness of the new lamp makes breakage in shipment negligible and permits of the use of the lamp in places where the tungsten filament lamp had been considered inapplicable. When burned tip up, no trouble is experienced with the short circuiting of adjacent strands of filament which sometimes occurred with the older lamps. Since the filament consists of but one piece cut from a spool of wire, it is more uniform in cross section and resistance than the different portions of filament which were assembled in old lamps. The lamps thus far marketed have shown great uniformity and have been almost entirely free from abnormally early burnouts.

These lamps are to be had in the same wattages and approximately the same bulbs as other tungsten filament lamps, forming a complete line for both train lighting and regular multiple service. We understand that Mazda Tungsten lamps are not now made with any other than the drawn wire filament.

The following records show how successful has been the use of large size tungsten lamps of the improved type:

PERFORMANCE OF LARGE LAMPS WITH TUNGSTEN FILAMENT.

Washington Terminal Company—Average life, 1,493 hrs.; 2-500 watt 6.6 amp. series. Suspended in an inverted position.

Halle Bros. Store, Cleveland, O.—Average life, 2,650 hrs.; 38-500 watt 110 volt multiple.

Pullman Company—Average life approximately 1,800 hrs.; 1,500 mostly 250 watt 110 volt; few 100 and 150 watt 110 volt. Replaced arcs.

Chicago, Milwaukee & St. Paul R. R.—Last record, 1,500 odd hrs. In freight yard, Milwaukee, Wis., 500 watt 110 volt lamps.

Large tungsten units and tungsten clusters are being used in many cases to replace arc lamps of the old type. They possess the decided advantage of requiring no attention other than to replace the burnt out lamps.

The Cooper-Hewitt Lamp Co. has developed a double tube mercury vapor lamp for giving a more powerful light source without increasing the size of the unit. This company has increased its guarantee of tube life and now guarantees a loss of not more than 25 per cent of the tubes in any installation during the first year, and not more than 50 per cent in the second and succeeding years. An average tube life of 4,500 hours is claimed.

The Cooper-Hewitt Co. has also developed the quartz tube lamp. In this lamp a tube of about 3″ in length gives the same light flux as a glass tube 3 ft. long. The quartz will withstand a very high temperature and on account of this high temperature the light has a different quality than that from the ordinary mercury vapor lamp. More red rays are emitted and the light has not the greenish tinge which has been an objection.

C. E. Franche & Co. report the development of tint frosting lacquer for coloring lamps to harmonize with interior decoration. The lamp is first dipped in weather proof frosting and when dry dipped again into a transparent lacquer giving the color desired.

Shades.

During the past year the Holophane Company has undertaken a thorough study of the requirements of railway car lighting, and the development of suitable lighting accessories to meet those requirements. This study includes a separate consideration of sleeping and parlor car lighting, day coach lighting, dining car lighting, buffet or library car lighting, postal car lighting, and baggage car lighting. The study of the lighting requirements for each of the above classes of service has been completed. Reflectors and enclosing globe units to meet these requirements have been designed and placed on the market as outlined below. Additional reflectors and enclosing globes to completely meet all requirements will be designed by the Holophane Company within the coming year.

Sleeping and Parlor Car Service.—For this service, the Holophane Co. has designed for the Pullman Company an enclosing reflector-bowl unit, which complete unit has been designated by the number 8327. This unit has been designed for use with the standard 50 watt, G-30 clear bulb train lighting lamp, and when used with this lamp gives a greater efficiency than any other enclosing globe unit which has as yet been placed on the market. The above unit has been designed for service as a center deck unit, to serve as the main lighting of sleeping and parlor cars. As an auxiliary unit, for side bracket service and for ceiling service in passage-ways, a small reflector bowl unit, No. 8323, has been designed. This latter unit is intended to be used with either the 15 watt or the 25 watt G-18½ clear bulb train lighting lamps. This unit is likewise very efficient, second only to the No. 8327 unit. The above are also entirely suitable for use in dining car service.

Day Coach Service.—For this service three types of unit have already been designed. It is expected, however, that it will be found desirable to add other types, such other types giving the same illumination results, but presenting differences in artistic effect. A bell shaped reflector, No. 8226, having a 2¼″ heel has been designed for center deck lighting. This reflector is designed to be used with a 50 watt, G-30 clear bulb train lighting lamp. When used with this lamp the unit gives the remarkably high efficiency

of 6 lumens per watt in the lower hemisphere.

A bell shaped reflector, similar to the No. 8226 but having a 3¼ in. heel and being slightly larger, has been designed, this reflector being designated as E-150 plain edge. This reflector has practically the same efficiency as the No. 8226 reflector, and is designed for service where a slightly larger reflector is desired, and where the fixture calls for a 3¼ in. heel. The Holophane Co. considers the use of a 3¼ in. heel for the center deck unit is better practice than the use of a 2¼ in. heel.

A bell shaped reflector, I-40 plain edge, has been designed for half deck lighting. This reflector is designed to be used with either the 15 watt or the 25 watt, G-18½ clear bulb train lighting lamps, the latter lamp being recommended as much preferable in order to obtain sufficiently high intensities. Half deck lighting in day coach service is recommended by the Holophane Company only in special cases of suburban service where the crowding of the aisles by the passengers is counted upon as a regular occurrence.

Dining Car Lighting.—The Holophane Co. has for several years been offering an enclosing reflector-plate unit for this service. This unit has been known as the No. 7430-743A, or No. 7430-743B unit, the first named unit being used in half deck lighting, while the latter unit was used in center deck lighting. Both the above units were designed for use with the 15 watt or 25 watt, G-18½ clear bulb train lighting lamp. On railway systems where the car lighting maintenance has been carefully looked after in an adequate and systematic manner, the above units have proven very satisfactory. On railway systems where the battery voltage is frequently allowed to drop to an unduly low value, or where there has been neglect in keeping the reflectors reasonably clean, the above units have not given sufficiently high intensities. The Holophane Co. is therefore at the present time designing a new center deck 50 watt unit for dining car service, this unit to be used as auxiliary to a half deck 25 watt unit employing a No. 7430-743A glass ware.

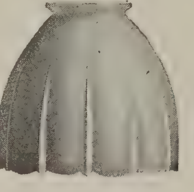
Buffet or Library Car Lighting.—The usual arrangement of chairs in buffet or library cars is with the back of the chairs toward the outside of the car. With this arrangement of chairs, half deck lighting is very decidedly preferable to center deck lighting. The Holophane Co. is now designing an enclosing globe 50 watt unit for this service. This unit is designed to be partially set up into the half deck, projecting below to a distance of 3 or 4 inches.

Postal Car Lighting.—For postal car lighting, it has been found that two units are required, one for the main body of the car, the other for the letter case end. In postal car lighting, high efficiency and the avoidance of glare are important considerations, while the artistic effect is a consideration of very minor importance. In view of these facts, the Holophane Co. considers that steel reflectors are preferable to glass reflectors for postal car service. They have accordingly designed the No. 451 and No. 452 reflectors for this service, the former being designed for the letter case end of the car, the latter for the body of the car. Both reflectors are designed for use with the 50 watt G-30 clear bulb train lighting lamp, thus permitting the use of a minimum number of units per car, with resultant saving in initial installation and in maintenance costs.

Baggage Car Service.—A study of the requirements of baggage car lighting shows that the No. 452 reflector, designed primarily for postal car lighting, is admirably fitted for baggage car service. It should be mounted considerably higher and at considerably wider separations than when used in postal car service.

Miscellaneous.—In addition to the above, the Holophane Co. has designed a reflector, BAE-40 Mahogany, for dining car, kitchen and pantry lighting. The present common practice of using bare lamps in dining car, kitchen and pantry is considered very objectionable because of the serious degree to which it cuts down the efficiency of the eye. The BAE-40 Mahogany reflector is designed for use with the 15 watt or 25 watt, G-18½ clear bulb train lighting lamp. It is a steel reflector with a 2¼ in. neck, and has a very attractive mahogany outside finish.

The Macbeth-Evans Glass Co. has brought out a number of new reflectors of Alba glass, such as No. 3439 A-B & C, which are especially designed for car lighting work. Also a new large shade for center deck lighting made especially deep in order to completely shade the lamp. For dining car lighting a small portable No. 4513 has been designed. This is made of a special shade of amber glass, satin finish and decorated with brush gold. Shallow bowls for center deck and dining car use, elaborately decorated in various designs, are now being furnished together with sleeping car berth lights to match.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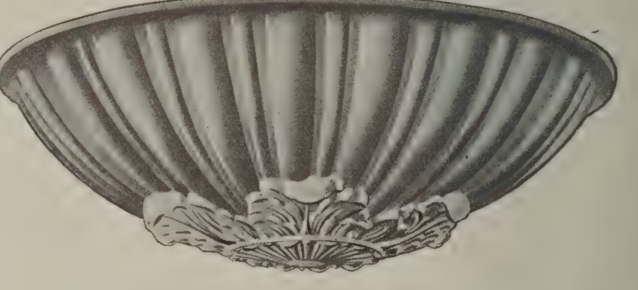
ALBA REFLECTORS.


ALBA BOWL No. 3439.

There has been considerable improvement in Alba glass itself in the direction of a smoother texture, whiter color and absence of selective absorption, which means that a color of the light source is transmitted unchanged through the glass.

Safety Car Heating & Lighting Co. has developed a one-piece glass shade or bowl for car lighting service known as the "Corona." The upper half is made of frosted glass, the lower half corrugated or fluted clear glass. The upper half serves as a reflector, and the lower half as a diffusor. This shade is made in various sizes.

They have also developed what is known as the "Opalite" open glass shade made of thin opal glass. A modification of this is the "Peridot," which has a thin veneer of pale green glass on its outside surface. These shades are used for coach lighting and in all places where open shades are appropriate. Steel reflectors for baggage and mail car lighting have also been developed. Mail car reflectors are built in spe-

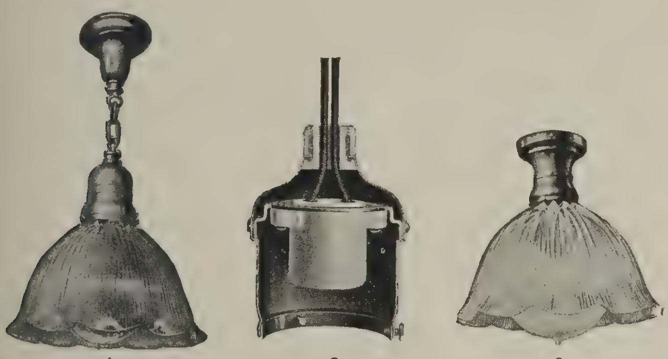
cial shapes for directing illumination to the sorting plane. An adjustable decorative table lamp is another improvement.

The Safety Company made an elaborate report which is published in full on advertising pages 27 to 38.

The Wheeler Reflector Co. has developed the "Para-Steel" reflector for use in baggage and mail car lighting. This is furnished with either an enameled or aluminum finish inside surface.

Fixtures.

The Adams-Bagnall Electric Co. has developed what is known as the "Abolite." This is a lamp and shade holder with a special positioning device which enables the same fixture and lamp to be used with either ex-



1.—3¼-Inch Pendant Abolite. 2.—Cross Section of 2¼-Inch Pendant Abolite Showing Positioning Device Thrown Downward to Give "O" Position. 3.—3¼-Inch Ceiling Abolite.

tensive or intensive reflectors. Industrial "Abolites" include also an enameled steel reflector attached to the fixture by phosphor bronze spring. The detail of this improvement is shown in the accompanying cuts.

Delta Star Electric Co. reports as follows: Our line of lighting fixtures for use in railway shops has been extended by the addition of single and multiple unit fixtures both with and without enclosing globes. These enclosing globes have been added to our medium size fixtures in order that breakages due to cleaning may be eliminated, and it is now only necessary to clean the globe rather than the lamps. A large fixture has also been developed for use in shops in place of arc lamps. This fixture will take lamps up to 250 watts for either series or multiple lighting and is provided with an enclosing globe.

Safety Car Heating & Lighting Co. has developed the safety shade holder shown in the accompanying illustration. The glass shade is inserted by a slight upward pressure causing the split cone grip to expand over the head at the top of the shade and ride into the outer groove at the neck. This holds the shade temporarily while the operator with the same hand screws home the follower nut, firmly gripping the shade. This operation permits the use of one hand for carrying shades while the other hand secures the shade in the holder—a decided advantage in car cleaning. Sufficient resiliency is provided for expansion of the glass when heated.

This company has also designed a large number of decorative car lighting fixtures. An especially useful improvement is a porcelain receptacle in which the thread contact is molded in the porcelain body, preventing any rattling of the lamp in the socket. A spring base contact obviates the difficulty formerly encountered of breaking contact due to vibration of the car.

Detailed descriptions of the improvements mentioned are given on advertising pages 27 to 38.

IV.—FANS.

The Adams-Bagnall Electric Co. has during the past year taken over the Jandus fan. The chief improvement made on this fan has been the riveting together of the laminated pole pieces on the fan motor which makes it easier to take apart and repair.

The Diehl Mfg. Co. reports the use of a sirocco type fan in the dining car ventilation. This is a positive pressure blower, the blades being enclosed by a rim. Ninety per cent of all the 12 in. fans built by this company are of the single speed variety while 60 per cent of the 9 in. fans are single speed and 40 per cent three speed. This seems to indicate that elimination of auxiliary speeds is considered an improvement.

V.—MOTORS AND GENERATORS.

The Burke Electric Co. reports the development of a line of mill type motors of extra heavy design. Casings for these motors are built of heavy boiler plate in accordance with best practice in boiler construction and have great rigidity and strength. They are of the commutating pole type and are capable of handling great overloads.

This company has also developed a synchronous induction motor, which combines the good starting qualities of the induction motor with the high power factor of the synchronous motor. This machine is shown herewith. It is especialy adapted to use in railway shops using alternating current power.

The Crocker-Wheeler Co. has developed a line of direct current interpole motors with an improved reaction type brush holder and dust proof bearings. They have also brought out a line of 25 cycle, 3 phase, alternating current motors. Form wound coils are used for the stator windings to facilitate repairs in case of injury.

The Reliance Electric & Engineering Co. has brought out the Reliance speed cutting dial which shows the correct speed for the working of any kind of metal. Speed adjustment is made by simply revolving the dial to the point opposite the indication for the metal to be worked.

The Westinghouse Electric & Mfg. Co. report on improvements made in motors and controlling apparatus for Railway Electric Traction as follows:

Motors.

In spite of the excellence of the interpole railway motors, in use a year ago, there have been further improvements suggested, and put in force in the past year.

The use of forced ventilation to increase the capacity of the motors has been tried out on a large scale on the Pennsylvania and Long Island Railway cars. The motors have a nominal rating of 220 horsepower. The use of forced ventilation enables the motors to be operated at a much higher continuous rating than would be possible without it. The method of applying forced ventilation is unique. It has been described in the technical papers, but may be briefly mentioned here.

A small motor-driven blower, or rather, pair of blowers, is mounted underneath the truck bolster, and each fan furnishes air to one motor. The blower motor has a fan on each end of its armature shaft. The air supplied to these blowers is taken from well up the side of the car, so as to avoid to the greatest extent the introduction of dust and dirt from the roadbed into the motors.

The use of forced ventilation has been quite common on locomotives—notably the New York, New

Haven & Hartford Railroad Company, the St. Clair Tunnel, the Spokane & Inland, and others, for some years, but this is the first time that forced ventilation has been applied to car motors on any large scale.

Field Control

The speed of the passenger locomotives on the New York, New Haven & Hartford Railroad, when operating on direct current, is controlled by the varying strength of the field of the motors. This system was so eminently successful, having been operated for about four years, that the same plan was adopted for the Pennsylvania locomotives. These locomotives have only two motors and consequently would not have as wide a range for speed control of the motors, as locomotives having four motors, connected in series, series parallel, and parallel. On the Pennsylvania locomotives, the motors are connected, first, with full field series; second, normal field series; third, full field parallel; fourth, normal field parallel. This control thus gives four highly efficient operating speeds. The full field gives an enormous tractive effort at low speeds, and the normal field enables them to operate comparatively heavy loads, at high speeds, thus enabling a motor of given capacity to operate over a much wider range of speeds, and less than would be at all possible without the field control. This whole system has been remarkably successful, and has in no case ever given the slightest amount of trouble. The commutation of the motors is perfect, regardless of the field strength, and proves conclusively the great flexibility of the modern interpole railway motor, and its adaptability to conditions of operation, which would not be possible with the old non-interpole form.

High Voltage Direct Current Apparatus.

We have taken a contract for equipping the Piedmont Traction Co. and the Greenville, Spartanburg & Anderson Railway Co., which form two branches of a new railway system in North and South Carolina, with 1,500-volt direct current apparatus. This is a distinct advance over any direct current lines, and is moreover the largest installation ever undertaken, as it calls for the equipment of about 135 miles of railway, and includes both car equipments and locomotives; the latter to be used for hauling freight. The motors to be used for these equipments will be the standard type of interpole motors, especially designed for operation on 1,500 volts—two motors permanently connected in series.

The control is a modification of the standard "HL" type, which will be mentioned hereafter. 1,500-volt current was adopted, as it was not felt that sufficient advantage could be secured from the use of 1,200 volts to enable the service to be handled satisfactorily.

One of the improvements on this 1,500-volt equipment is the use of the dynamotor, which drives the compressor by means of a friction clutch of a standard automobile type, which is automatically cut in when the air pressure reaches a certain limit. The dynamotor ordinarily furnishes power for the control, and lights, but in this case it serves also to operate the compressor without the use of a separate motor. The dynamotor is arranged so that it will operate on the 600-volt lines at the regular speed, thus enabling the air compressor to be kept up much better than is possible where 1,200-volt compressor motors are used and operated at half speed or less, on the low voltage lines.

Multiple Unit Control.

Marked advances have been made in the use of multiple unit control, both for city cars and for interurban work, in the past year. Our new "HL" control has been very well received, and meets the demand for a simple effective control, which will replace the hand control on the platform of the cars without great addition in either cost or weight. In many cases, in fact, the weight is less with the "HL" control than with the old hand controllers. The advantage of getting a controller handling heavy motor currents off the platform is becoming more important every day, and we look for a rapid turning of the sentiment of operating men towards this form of controller. The "HL" controller not only employs a smaller number of switches than any multiple unit control heretofore used, but the number of interlocks is reduced so much as to enable them to be practically forgotten, as far as cost of maintenance is concerned. Line current is used for operating the valve magnets for the switches, and a form of resistance is used in series with these which is of the most efficient form, being practically fool-proof.

Latest Type Single-Phase Locomotive.

Single-Phase Railway System.

Steady advance has been made in the use of single-phase apparatus for railway work. In the past year, the Rock Island & Southern Railway has begun operation with 11,000-volt single-phase current on the trolley, and the apparatus has operated with the greatest success. The New York, New Haven & Hartford Railway Co. has been extending its electrified zone, and has purchased a number of different locomotives with a view to establishing the best type of both passenger and freight service. The latest locomotive is one which is equipped with four driving axles, but has eight motors, there being two motors geared to a quill surrounding each axle. This equipment, while on the face of it appears more complicated, is in reality lighter, cheaper, and simpler than the locomotive of the same capacity having four motors of the same total capacity. This type permits the use of small motors for locomotives of large capacity, and thus renders repairs of the motor a much simpler matter. Each of the small motors has practicaly one-half the number of brushes, brush holders, or armature field coils, etc., as one large motor, so that there is the same total number of these parts on the locomotives as with the large motors. There are, therefore, no more chances for failure of the small motors than for the large ones, and the cost of repairing a small motor, as the result of a defect, will be very much less than repairing the same defect in a large motor. Both motors are geared to the same gear,

thus permitting the use of only one gear on the quill, where the large motor requires twin gears. It is believed that this type of locomotive marks a distinct advance in the art.

This locomotive has the two motors on each axle connected permanently in series, and as each of these motors is wound for practically the same voltage as the one large motor, this type thus is equivalent to doubling the voltage of the single-phase motor, and cutting the current in half. This is a distinct advantage in saving the car wiring, and in reducing the capacity of the control switches. The locomotive is especially well adapted for operation on direct current for the same reason.

The mechanical features of the locomotive, having this electrical equipment, are also of a very novel form. We will not attempt to describe them here, however, feeling that this description pertains more to electrical features, and the full description of this locomotive will be found in the technical papers at an early date.

We have also built for the New Haven Co. a straight A. C. switching locomotive, which from the time of its receipt at Stamford, has been on duty at least twenty hours per day. It has been a great success, and is doing the work of two steam locomotives. An order has been placed with us for fifteen additional switching locomotives of this type. The weight of each is 80 tons.

The Boston & Maine Railroad Company has in the last few months electrified the Hoosac Tunnel with 11,000-volt single-phase current, and has been operating since the latter part of May, handling all of their service with straight single-phase locomotives. Six locomotives are now in use, each having a rating of approximately 1,500 horsepower. Half of these are geared for a minimum speed of approximately 30 m.p.h. for handling heavy freight trains through the tunnel. The others are geared for 50 m.p.h. and are used for handling the passenger service. These locomotives weigh approximately 130 tons each. Two of them were delivered four months after receipt of order. This installation is especially notable on account of the difficulties encountered in installing the apparatus, and the faultless operation that has been secured when using 11,000 volts in the tunnel, which has heretofore been so full of smoke as to render it almost impossible to see in it.

The New York, Westchester & Boston Ry. Co., which is a subsidiary of the New York, New Haven & Hartford, is also being electrified with single-phase at 11,000 volts, equipments to be interchangeable with those on the New Haven line, but are to operate on alternating current only. The equipments will be used for high speed passenger service with multiple unit cars.

Most of the troubles on single-phase railways in the early days of installation were due to operation at abnormally high speeds—at speeds for which the equipments were not designed. The high speeds were made possible because of the fact that the line voltage was always good, and an over-voltage tap on the transformers was usually supplied. Further, the motors have naturally a very steep speed characteristic, which enables them to reach a much higher speed than would be possible with a direct current motor with the same gearing. This trouble from overspeeding is now avoided by the use of what is known as an *overspeed relay*. This is electrically operated, and placed in the control circuit in such a way as to be controlled by the current and voltage applied to the motors. It is so arranged that the control circuit will be opened on the higher notches of the controller, if the speed reaches a certain definite limit. It is thus impossible to operate these cars above this limit, unless there is a long down-grade of 1 per cent, which is unusual on interurban lines. In any case, if they are operated at excess speeds, they are operated without power on the locomotives. This scheme might safely be applied to direct current lines, as well, since extreme high speeds are not only dangerous, but in practically all cases are unnecessary, and are expensive, because of the extra power consumption which is involved.

Line Construction.

Various improvements have been made in the trolley construction for both direct current and the single-phase systems. New hangers introduced, which are not only lighter, but more effective than the old ones. Splicing ears of the improved type developed, etc., etc. In fact, there is no line of apparatus used on railroads which has not shown a distinct advance in the past year.

VI.—CONTROLLING DEVICES.

Electric Controller & Mfg. Co. reports the development of a dynamic braking controller for hoists. This is nothing more or less than a device for converting the hoisting motor into a generator during the lowering, the resistance values being so proportioned as to limit the lowering speed to a safe armature speed. If the load is so extremely heavy some power is returned to the line. To bring the load to rest the control lever is pulled to the off position which increases the dynamic action until the armature is brought to a standstill. This relieves the hand or magnetic brake of all stopping duty and makes it a holding brake only, thereby materially increasing its life.

There has been during the year a considerable increase in the use of automatic motor starters. Operation of those built by this company may be briefly described as follows:

Up to the advent of this line of starters the method of securing the time element was by some device such as an air or oil dash pot, or the mere inertia of the moving parts. This mean that the motor was being started always in the same time regardless of load. The ideal manner of doing this is to make the time element vary with the load, that is, if the load to be started is light, the armature may be put across the line very quickly; if the load to be started is heavy this time element should be drawn out so as to minimize the current to proper commutating values.

To secure this end seemed difficult without a complication of relays, etc., until the discovery of the principle embodied in the magnetic switch used in connection with E. C. & M. Starters. This magnetic switch is operated by a solenoid carrying a series winding instead of the usual shunt winding. If the current flowing through the armature is heavy, the switch will not close. When the current dies to the proper predetermined value, the switch promptly closes. This is due to a peculiar arrangement of the magnetic circuit. When the current flow in the motor armature is heavy, the flux in the magnetic circuit of this switch is accordingly great, and it leaks across a path which opposes the closure of the switch. As this flux decreases, the leakage decreases and the switch ultimately closes at the proper time.

The Reliance Elec. & Engineering Co. have developed an automatic starting device for their adjustable speed motors. Starting and stopping is effected by simply pressing a button, the starting resistance being

cut in automatically. Control devices are so arranged as to be at the hand of the machine tool operator which lessens the idle time of machines.

The American Electric Fuse Co. and the Allen-Bradley Co. have brought out carbon pile rheostats for motor starting and battery charging service. These are simply piles of carbon disks, the resistance of which is varied by a pressure exerted by a screw. Very fine adjustment of resistance is possible by means of these rheostats.

The J. Lang Elec. Co. have brought out an induction motor starting switch for the control of polyphase induction motors. The arrangement of this switch is such that it is impossible to place the motor on running voltage without first placing it on starting voltage; also the switch cannot be left on the starting side.

VII.—WIRE AND WIRING DEVICES.

No change has been made in insulated wires during the past year, neither has there been any material change in conduits. Various manufacturers of wiring devices have brought out certain improvements, among which are the following reported by the Crouse-Hinds Co.:

Berth light fixture.

Charging plug and receptacle.

Deck rain condulet and contact fittings.

Yard box for charging receptacles.

Combination switch and cutout box.

Standard for securing "C" condulets to woodwork.

Battery terminal connecting box and fittings.

Battery terminal connecting box and fuse box.

Battery box entrance condulet.

One-half inch, ¾-inch and 1-inch type bushings. (1 and 2-hole bushings.)

Swivel condulet for telephone jacks or cars.

Machine terminal connecting box and fittings.

Junction box for overhead wiring.

Junction box for underneath wiring.

Holders for securing trough reflectors to "C" condulets. (Mail cars.)

Conduletto fitting with metal cover for railway car work.

The Hart & Hegeman Co. have redesigned their Barrier switch making the porcelain heavier and stronger and putting in a heavy steel spindle which rotates on steel bearings and permits the switch to stand very rough service. The Barrier device allows the switch to break heavy momentary overloads by the passing of the switch through a narrow enclosed slot of the porcelain, effecting a mechanical blow-out of the arc.

The Daum Mfg. Co. have, during the year, made some improvements in their refillable fuse shells. These shells conform to National Electric Code Standards.

A refillable shell has also been developed by the Trio Mfg. Co.

VIII.—TRANSFORMERS, RECTIFIERS, ETC.

Improvements made in transformers during the year have been chiefly minor changes in design and improvement in the iron used in cores which have slightly reduced core losses.

The chief improvement made in mercury arc rectifiers has been in the glass bulbs. Bulbs showing a life of upwards of 4,000 hours are no longer uncommon. This, of course, is an important improvement since the cost of new bulbs is practicallly the only maintenance expense with this type of rectifier.

Some progress has been made in the development of a rectifier with a graphite arc valve, but as yet none of these have been built in sizes large enough to be useful in railway work.

IX.—INSTRUMENTS.

Hoskins Mfg. Co., which now carries the line of meters formerly manufactured by the International Electric Meter Co., report the development of a direct current portable volt-ammeter with which simultaneous reading of voltage and current can be taken. The principal improvements embodied in this instrument are resiliently mounted armature bearings which prevent injury from rough handling and an improvement in the pole pieces. The old practice was to mill each pole shoe and fasten them together with brackets. With this method it is impossible to secure a hole truly round, which is necessary for uniform air gap. Consequently the scale will not be evenly divided. The method now employed in making this meter is to braze the pole shoes together and drill the hole afterward giving a uniform air gap and an evenly divided scale.
The Wagner Elec. Co. has put on the market a very compact instrument for train electricians, small enough to rest on the window of a pullman car.

X.—MISCELLANEOUS.

While not altogether a matter of improvement in electrical equipment, the freight handling system installed by the Sprague Elec. Co., for the freight terminal of the M. K. & T. Ry., in St. Louis is so much of an advance that the committee considers it worthy of mention. The essential feature of this system is a series of small trolley hoists running on overhead I beams suspended from the ceiling. There are 18 of these hoists, 2 of 6 ton capacity and the remainder of 2 ton capacity each. They are arranged to pick up freight carrying trucks and deposit them anywhere about the building. The hoisting speed is 60 ft. per minute, the lowering speed 120 ft. per minute, and the maximum traversing speed 500 ft. per minute. Direct current at 230 volts is furnished to the traveling hoists by a small third rail. This system does away almost entirely with hand trucking of freight, and allows freight to be delivered on the floor above the track level.

A similar system designed by the same company has been installed in the store houses of the Rock Island shops at Silvis, Illinois.

The Otto Gas Engine Co. has developed a gas-electric car for furnishing power for the operation of electric track tools. The car carries the men and tools to where they are needed and then supplies the necessary power. It is virtually a self-propelling portable power plant.

H. C. Meloy, Chairman.
F. Phalin.
C. J. Causland.
D. P. Morrison.
Edward Wray.

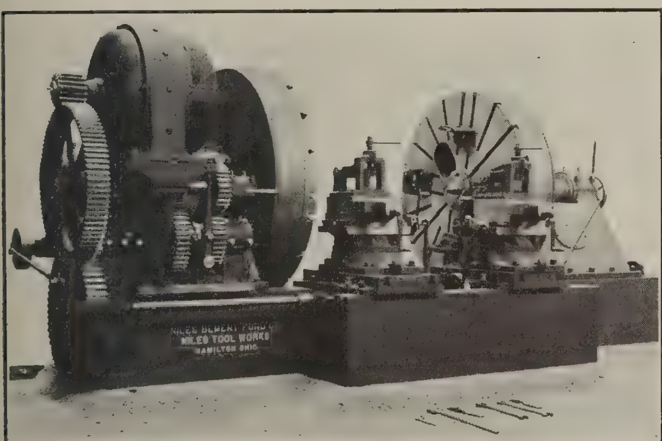
Report of Committee on Shop Practice

The Committee appointed by you, for the purpose of investigating and reporting on railroad shop practice, has selected as a proper subject the use of alternating current as compared with direct current for the operation of various tools and appliances found in railroad shops.

There is no doubt but that both kinds of current have advantages and disadvantages; therefore, we must determine whether or not the objections to either are more than offset by practical benefits which can be derived therefrom. There are at the present time in vogue what might be termed three systems of generating current for operating shop machinery; namely, alternating current, direct current, and a combination of both.

The first modern repair shops built used direct current exclusively for their operation. This was due both to lack of knowledge concerning characteristics and uncertainty regarding feasibility of using alternating current; also the high cost of motors and generating apparatus which then prevailed.

About seven or eight years ago, shops were installed using a combined alternating current and direct current system. In some cases both direct current and alternating currert prime generating units were used, and in other instances alternating current prime generating units only were installed, and direct current was obtained through the medium of a motor generator set or rotary converter. The advantages of the latter arrangement are numerous, but mainly the flexibility of operation and the high efficiency of large units would form a determining factor in deciding upon this method in preference to the former.



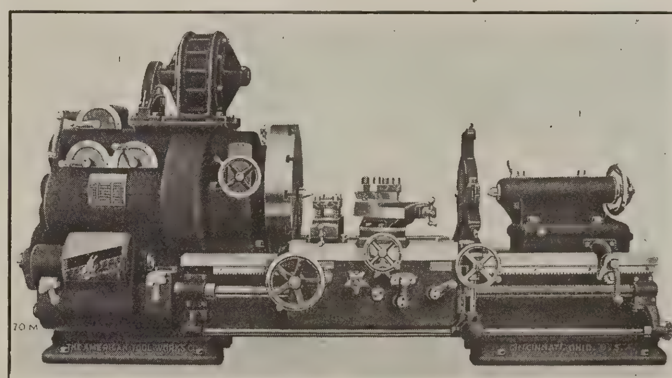
Variable Speed Motor Driving Wheel Lathe.

During the past five years several installations have been made where alternating current is used exclusively, probably the most prominent being that of the New York, New Haven & Hartford shops at Readsville, Massachusetts. As stated in last year's report by the Shop Committee, it is somewhat dubious, even at this time, whether or not the best plan is to use alternating current to the exclusion of direct current, as no doubt exists but what increased output can be obtained from certain classes of machine tools by the use of variable speed D. C. motors, and, in view of the present high labor costs, this is certainly an important consideration. The recent development of multi-speed alternating current motors, and increased use of variable speed alternating current motors in conjunction with mechanical gear changes, however, may in a short time alter present engineering practice.

Practically all of the machine tool builders have now so arranged machines that constant speed motor drive may be used through the medium of mechanical gear change and in small shop installations where power plant capacity does not exceed 500 kw., it would seem inadvisable to complicate power distribution by installing both alternating and direct current; inasmuch as the relative saving in labor would be less than in a large shop where, as in a great many cases manufacturing is done for smaller shops on the system.

In the first place, we must consider the original cost, which is always an important factor, in our calculations; beginning at the power plant and ending at the motors which will drive the machinery.

The cost of certain parts of a power plant will remain practically constant, regardless of whether or not direct or alternating current is used, provided, of course, that the same method of operating generating units is decided upon. If alternating current turbines are compared with direct current generators with cross-compound condensing engines, the cost of building and foundations would be considerably greater for the latter installation; but boilers, condensers and other accessories would remain practically the same. We should assume, however, that the comparison would be between alternating current turbo-generators, and direct current turbo-generators; in which case the cost of building and all equipment, exclusive of the generating units, would be essentially the same. Where alternating current is decided upon the installation of turbines is practically the only thing considered, as recent developments in the design of non-condensing units makes them eminently satisfactory where water cannot be secured for condensing purposes. In the case of direct current many engineers prefer engine type units to turbo-generator units.



Constant Speed Motor Driving Lathe.

We give below a table showing approximate first costs of generating units in a power plant installation which may be of benefit in reaching a decision as to the system which can be most economically installed. In order to make this table of practical benefit, we have assumed that this plant is to provide power and light for a large locomotive and car repair shop, with fifty pits in erecting shop, and sufficient car repair facilities to take care of the division on

which the shop is located. Undoubtedly, for a shop of this character and size, most engineers would decide upon three prime generating units of approximately 750 kw. capacity each; and, if a combination system is considered, two motor generator sets of approximately 300 kw. capacity each, to provide direct current for the variable speed machine tools and, possibly, for the cranes, would be installed. The estimates for such an installation would be given as below:

consideration transmission line losses alone, we can transmit nearly four times the power at 440 volts alternating current as at 250 volts direct current, with the same percentage of loss. In shop practice, however, the limited distance at which power is transmitted generally makes the current carrying capacity of the wire a determining feature, rather than the losses through resistance. On this account it will probably be found that the transmission lines for alternating current will require about 60 per cent as much

COMPARATIVE FIRST COSTS OF DIFFERENT TYPES OF PRIME MOVERS.

	A. C. (Turbine.)	A. C. (Eng. Type Generat. Units.)	D. C. (Turbine.)	D. C. (Eng. Type Generat. Units.)	A.C. and D. C. (Turbine.)	A.C.& D.C. (Eng. Type Generat. Units.)
Three 750-KW condensing alternating current turbo-generators	$39,000				$39,000	
Three 1,125-H. P. cross-compound condensing engines		$42,000		$42,000		$42,000
Three 750-KW alternating current engine type generators		30,000				30,000
Two exciting units for alternating current generators, one to be steam driven and one motor driven	2,500	2,500			2,500	2,500
Three 750-KW direct current turbo-generators			$65,000			
Two 300-KW direct current motor generator sets, consisting of alternating current synchronous motor and 250-volt generator					10,000	10,000
Three 750-KW direct current engine type generators				30,000		
	$41,500	$74,500	$65,000	$72,000	$51,500	$84,500

We find from the above that the first cost for generating units will be as follows:

Alternating current (turbines)	$41,500
Alternating current (engine type generating units)	74,500
Direct current (turbines)	65,000
Direct current (engine type generating units)	72,000
A. & D. current (turbines)	51,500
A. & D. current (engine type generating units)	84,500

Especial attention is called to the fact that the above estimate on a combined system contemplates the use of a synchronous motor in connection with the motor generator set as a power factor corrective device. It is the usual method for electrical manufacturers to rate alternating current generating units on the basis of 80 per cent power factor. By actual practice, however, it has been ascertained that the power factor usually prevailing in both manufacturing establishments and railroad shops, will vary from 55 per cent to 75 per cent, rarely being as high as 80 per cent. On this account it is generally advisable to install a synchronous motor in the power plant, which can either be efficiently used for driving direct current generators or used as a synchronous condenser, floating on the line to bring the power factor up to the desired point.

It is clearly seen from the foregoing that a straight alternating current installation is far cheaper in first cost, from the power plant standpoint, than either of the alternatives. Now the distributing system must be considered.

We are practically limited on account of commutation to 250 volts as a potential for transmitting direct current, but in the case of alternating current 440 volts or 550 volts are generally used. Taking into

of copper as those used for direct current. The percentage of loss, however, will, of course, be considerably less, on account of the higher voltage at which the current is transmitted.

The branch lines from the distributing switchboards to motors will, in a great many cases, require more copper where alternating current is used than where direct current is installed, on account of the fire underwriters' rules based on motor starting conditions; but the amount of copper used for this purpose is small as compared to that used for the main transmission lines.

It would not be amiss to consider at this time the merits of alternating current as compared with direct current for lighting. It has been customary where direct current is used to operate both arc and incandescent lamps from a 250-volt circuit. With an installation of this character, the life and efficiency of incandescent lamps are greatly reduced, and the arc lamps do not operate as successfully as on a 125-volt circuit.

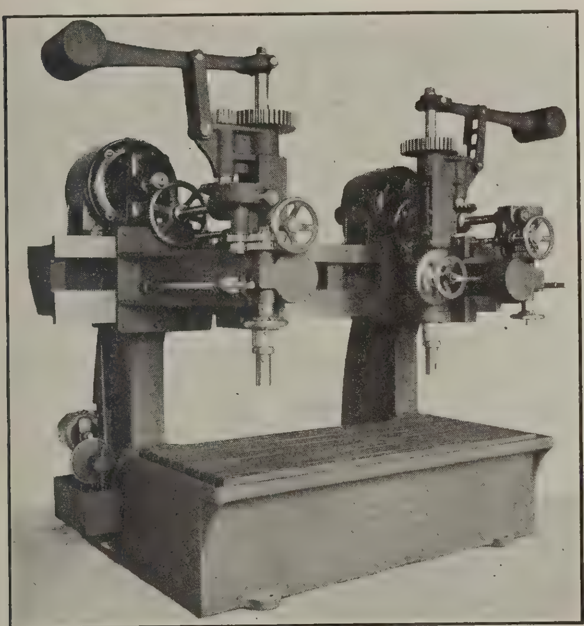
The development of the tungsten lamp for shop lighting has practically made imperative the use of 125-volt transmission, which in the case of direct current would require special generators for this service, on the assumption that 250 volts has been standardized upon for power service. It is very simple in the case of alternating current to obtain the low tension lighting voltage, as the transmission can be made at the full voltage of generating unit, and transformed to the desired potential near the point where used.

Some consideration must be given to the relative cost of alternating current and direct current motors for operating machinery and cranes. We would estimate that the cost of alternating current motors for individual and group drive would be less than direct

current motors, but the cost of alternating current motors for cranes will be somewhat in excess of direct current motors, as the fundamental principles of alternating current motor construction make it necessary to use on cranes much larger alternating current motors than direct current motors. The facility of speed control, however, is approximately the same, and it is doubtful if an operator could tell from the operation of the crane whether direct current or alternating current motors were applied.

As a general proposition, we think it only fair to assume that the difference in first cost of electrical equipment for a large railroad repair shop, based on the use of alternating or direct current, would be mainly represented by the difference in cost of the power plant equipment; as the saving in the transmission system, by using alternating current and the lower cost of alternating current motors for driving machine tools, would be practically counterbalanced by the increased cost of alternating current motor driven cranes and variable speed machines, where necessary to provide them with mechanical speed changes.

In making a decision upon the important subject covered by this report, we should bear in mind the possible necessity in the future of transmitting current for a long distance for the purpose of operating pumps, or furnishing light to depots or other property removed from the power plant. We must also consider the possible likelihood of purchasing alternating current from a hydroelectric company based on rates lower than the same current could be generated by the railroad.



Variable Speed Motor Driving Rod Boring Machine.

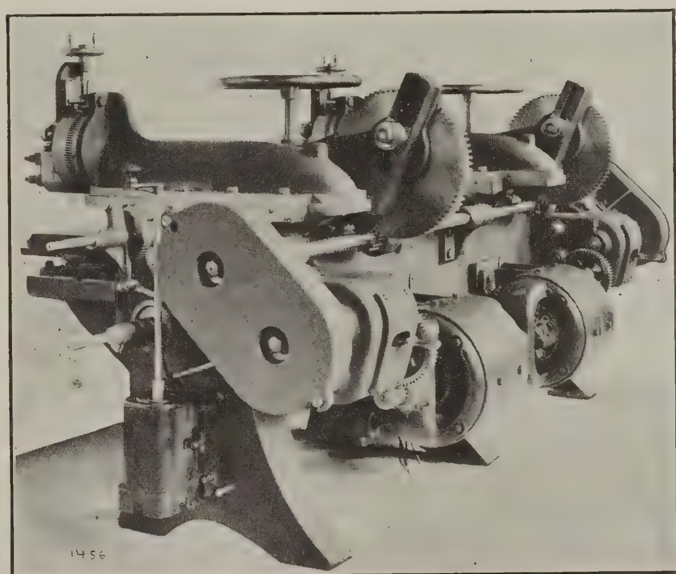
The general conclusion of the committee is that alternating current should be used exclusively in small division railroad repair shops, where the capacity of generating units in power plant does not exceed 500 kw., and that the combination of alternating current and direct current should be used in larger installations. The direct current units should be installed for the purpose of operating variable speed machine tools only. The use of alternating current for operating cranes, transfer tables, turntables and hoists is recommended as being wholly satisfactory, and no reason exists for converting alternating current to direct current for any of these purposes.

We trust that there will be developed, some time in the near future, an alternating current variable speed motor having the same characteristics as a direct current motor, where the variation of speed is obtained by field control. When this is developed, no reason whatever will exist for continuing the use of direct current in steam railroad repair shop practice.

USE OF COMPRESSED AIR IN STEAM RAILROAD SHOPS.

As a supplement to the report just presented on the use of alternating current as against direct current for railroad shop operation, the committee feel it their duty to call the attention of the members to the alarming increase in the compressed air consumption in shop practice.

The modern railroad shop of today under existing operating conditions requires compressor capacity of 1,000 to 10,000 cubic feet of free air. In order to obtain this volume of air, it is necessary to use steam representing from 150 to 1,500 boiler horsepower, which probably equals the amount of power necessary to operate all shop equipment driven by other methods.



Constant Speed Motor Driving Double Head Shaper.

We desire to unequivocally endorse the substitution of electric power for compressed air wherever possible, and the development of electric drive for hoists, riveters, chipping hammers, drills, etc., makes it wholly practical to eliminate the majority of pneumatic appliances.

In the opinion of the committee, it is also desirable to distribute a number of small compressors through the various buildings, these compressors to be electrically driven and arranged to automatically start and stop through pressure governors. While this method may not be wholly feasible under present operating conditions, it would not only be feasible but strongly advisable if the compressed air consumption is greatly reduced by the substitution of electrical equipment as above indicated.

There are few departments in a steam railroad shop where compressed air is required except during the working day, which represents a small proportion of the total time. The present practice is to place large compressors in the power plant for furnishing air to

the entire shop. In view of the fact that certain parts of the shop must have compressed air at all hours, it is necessary to operate these large compressors day and night under extremely uneconomical conditions.

Since the committee has not as yet obtained definite figures regarding the cost and efficiencies of compressed air generation under various conditions, they deem it inadvisable to wait another year before bringing this most important matter to the attention of all the members, who should be vitally interested.

C. J. Causland, Chairman.
C. L. Kincaid.
J. C. McElree.
J. H. Klink.
A. I. Totten.
J. Dixon.

Report of Committee on Specifications

Your committee on specifications have taken up the following subjects with a view of preparing specifications for same:

Electrolyte for lead batteries.
Incandescent lamps.
Rubber covered wire.
Hard drawn copper wire.

Our report on the subjects is as follows:

ELECTROLYTE FOR LEAD BATTERIES.

Method of Ordering.

1. Concentrated sulphuric acid having a specific gravity of not less than 1.835 or about 66 degrees Beaume at 60 degrees Fahrenheit will be purchased in amounts as the demands of the service indicate. Requisitions for this material must clearly state the strength of acid desired, as indicated by the specific gravity. Concentrated acid should be ordered having a specific gravity of not less than 1.835 at 60 degrees Fahrenheit corresponding to about 66 degrees Beaume. In case the specific gravity is not specified on the requisition, concentrated acid of not less than 1.835 specific gravity or 66 degrees Beaume will be ordered.

Material Desired.

2. The material desired under this specification is a sulphuric acid, free from impurities and sediment, and water white in color. Platinum, chlorine, nitrogen in any form, arsenic, manganese, copper, sulphurous acid and organic matter, when present in sulphuric acid to be used in storage batteries, are considered to be detrimental to the life and working properties of the battery, and must not exceed the figures shown in section 7.

Instructions for Diluting.

3. This acid must be diluted with distilled water before being used in storage batteries. The dilution should be made in a lead tank, adding the acid to the water with stirring. If water is added to the acid in diluting, there is danger of injury to the operator from acid which may be thrown out of the tank. After diluting, the solution should be allowed to cool and finally adjusted to the specific gravity desired. In diluting, about 75 pounds of water will be required for 35 pounds of concentrated acid to give an electrolyte of 1.200 specific gravity. After the electrolyte has become cool and any sediment present allowed to settle, the clear solution is ready for use. The electrolyte must not be added to the battery when at a temperature above 100 degrees Fahrenheit. Where there are no facilities for diluting the concentrated acid, electrolyte ready for use, having the strength required, may be ordered.

Requirements for Electrolyte.

4. If it is desired to specify electrolyte ready for use on account of having no facilities for diluting the concentrated acid, the specific gravity of the electrolyte required must be clearly stated. Electrolyte having a specific gravity of 1.200 or about 25 degrees Beaume is mostly used. In some cases a stronger electrolyte, specific gravity 1.300 or about 34 degrees Beaume is called for.

Packing.

5. Both the concentrated acid and electrolyte must be shipped in clean glass stoppered bottles, or carboys, properly packed to avoid breakage. The specific gravity to be plainly marked and carboys stenciled "For Storage Battery Use."

Sampling.

6. When a shipment is received at any point, a sample of a quart of the electrolyte representing 50 carboys or less, or one pint of the sulphuric acid representing 10 carboys or less, must be sent by R. R. S. to the Department of Tests in a clean and dry glass stoppered bottle, carefully packed in a strong case and carefully cushioned to prevent breakage in transit, and accompanied by "Sample for Test" tag properly filled out, and the acid must not be used until report of test is received.

If there are several samples from the same shipment, each sample must bear a designating mark. The same designating mark must be put on the lot of acid which the sample represents, so that if any of the samples do not stand test, the acid represented by the sample can be selected for rejection.

Rejection Limits.

7. Shipments will not be accepted which:

(1) Have a specific gravity lighter than 1.81 for the concentrated acid.

(2) Have a specific gravity more than .01 lighter or .02 heavier than the specific gravity ordered for the diluted acid.

(3) Show any gasing at 70° Fahrenheit in two hours on open circuit ,when a small fully charged storage battery element of the Plante or formed type is placed in a jar filled with the acid adjusted to a specific gravity of 1.200. It is understood that the storage battery element used in this test does not show gasing under these conditions with electrolyte which is known to be of satisfactory quality.

(4) When the strength of the acid is adjusted to 1.200 specific gravity, contain any platinum or more than

.005 per cent Iron.
.001 per cent Chlorine.
.005 per cent Nitrogen in any form.
.002 per cent Copper.
.001 per cent Arsenic.
.001 per cent Manganese.
.010 per cent of impurities other than the above.

(5) When the strength of the acid is adjusted to 1.200 specific gravity, require more than .3 c. c. N/10 permanganate solution to produce a red color in 100 c. c. of the acid.

(6) When the strength of the acid is adjusted to 1.200 specific gravity, are not water white in color.

Claims for Rehearing.

8. Samples of rejected material are usually held at the laboratory one month from date of test report. Accordingly, in case of dissatisfaction with the results of test, the shippers must make claims for rehearing, should

they desire to do so, within that time. Failure to raise a question for one month will be construed as evidence of satisfaction with the tests, the samples will be scrapped; and no claims for rehearing will be considered.

INCANDESCENT LAMPS.

A committee consisting of J. R. Sloan and J. L. Minick was appointed to meet with the committees of the United States Government, the Railways and the Manufacturing Association. The attached letter will explain the difficulties this committee has encountered and we recommend that the same committee be continued and they be given more time to complete their report.

Altoona, Pa., October 10, 1911.

Mr. G. B. Colegrove,
Chairman Committee on Specifications.

Dear Sir:

Your committee appointed early this year, to take up the subject of specifications for the purchase of incandescent lamps, desires to report as follows:

At the meeting held at Washington, the committee presented a brief form of specification which was discussed at that time. Objections were made on the part of the manufacturers to the wording of several clauses, and since that time other objections have been made from time to time. In looking into the objections raised, your committee has found that there is good foundation for each of them. It is therefore the desire of the committee to have the time for investigating this subject extended so that each objection or criticism may be looked into and definite conclusions arrived at.

Among other things the suggestion has been made that the basis of inspection is not right; that is, that the number of samples taken from a package is probably too small, or that the number of lamps necessary to reject is too small. Objection has also been raised to the use of excess voltage test, due to the fact that very little is known at the present time as to the performance of tungsten lamps at wattages less than .9 watts per candle. An investigation should be taken up in this connection and carried along until some definite results can be obtained. As far as your committee is able to ascertain, the performance of tungsten lamps at wattages below .9 watts per candle seems to be quite erratic.

Your committee has found in the case of excess voltage tests that very few of those who are making use of this test are carrying on the test in exactly the same manner. Excess voltage tests should not be depended upon entirely as an indication of the performance of the lamps in actual service, and it is therefore desirable to give some consideration in our specifications to normal voltage tests. This test should also be looked into very thoroughly and accurate data obtained. In making use of both of these tests, the tests should be described in detail in the specifications.

Likewise the routine methods of collecting the data, plotting curves when necessary, and the drawing of conclusions should be looked into and outlined in detail.

As stated before and based upon the reasons given, your committee desire to have the time for investigating this subject extended for obtaining accurate data before recommending a specification to the association.

(Signed) J. L. Minick.

RUBBER COVERED WIRE.

On this subject we are not prepared to submit other than a partial report for the reason taht we have been unable to fully complete the specification to our satisfaction .

We have gone into the matter quite thoroughly and have made progress, although there are a number of minor points which remain to be taken up. We would therefore require more time in which to complete the work. Would recommend that a special committee be appointed on this subject.

SPECIFICATIONS FOR RUBBER COVERED WIRES AND CABLES.

This specification is intended to cover all rubber covered wires and cables purchased for this department or used by contractors in executing work for this department.

The specification consists of two parts:

Part 1 gives in detail the requirements of the conductors, tinning, rubber compound, braid, sheath, etc.

Part 2 treats of the inspection.

Part I—Requirements.

Each solid conductor or separate wire if a stranded conductor shall be soft drawn copper, having a conductivity of not less than 98 per cent Matthieson's standard.

Shall be of uniform circular cross section, smooth. clean, free from flaws, scales, and evenly annealed.

Shall have a tensile strength (timed or untimed) of 30,000 pounds per square inch.

Shall have an elongation (timed or untimed) in eight inches not less than:

20 per cent when under 0.010 inch in diameter.

25 per cent when 0.10 inch in diameter to 0.030 inch in diameter, inclusive.

30 per cent when larger than 0.30 inch in diameter.

The elongation shall be measured as the permanent increase in length due to breaking the wire in tension between marks placed eight inches apart. The fracture should occur in the length included between the marks.

Shall be continuous throughout its entire length without weld or splice.

Shall not vary in diameter more than one per cent when 0.010 inch in diameter or larger, or more than one-ten-thousandth of an inch when under 0.010 inch in diameter.

Shall be capable of being wound six times about a wire of its own diameter and then unwound. This operation to be repeated twice without breaking the wire.

A six-inch length shall be capable of making the number of complete twists shown in the following table before breaking. The twists to be made at the rate of eighty per minute.

Diameter.	Twists.
.0255 inch	272
.0315 inch	230
.0465 inch	156
.081 inch	101
.101 inch	63
.125 inch	62
.165 inch	45

All mechanical tests shall be made at a room temperature of from 60 to 100 degrees F.

Shall be covered with a heavy, uniform, smooth coating of fine tin adhering firmly to the surface of the wire free from fins, burs, or other imperfections.

The rubber compound shall be composed exclusively of the following ingredients, thoroughly mixed and vulcanized: Rubber, sulphur, other inorganic mineral matter and solid waxy hydro-carbons.

The finished product shall not contain less than 29 per cent, and not more than 32 per cent by weight of pure, up river, fine, dry, para rubber gum, exclusive of extract.

The vulcanized compound shall not contain more than 2½ per cent of sulphur in any form, and not more than 6/10 per cent of uncombined sulphur.

The vulcanized compound shall not contain more than 4 per cent of solid waxy hydro-carbons.

The total amount of acetone extract obtainable from the vulcanized compound shall not exceed 1¼ per cent, exclusive of free sulphur and waxy hydro-carbons. The extraction to be carried on for a period of eight hours. The sample to be obtained by the inspector from any part of the length of wire submitted for inspection. It shall be cut by scissors to pass through a twenty mesh sieve made of wire from 0.012 inch to 0.018 inch in diameter.

The compound shall be applied concentrically about the conductor and shall adhere closely to it.

The specific gravity of the vulcanized compound shall be not less than 1.5.

A sample of the vulcanized compound not less than 4 inches in length shall have marks placed on it two inches apart. This sample shall then be stretched at the rate of 12 inches per minute until the marks are six inches apart and immediately released, but not so as to fly back. Thirty seconds after release the marks shall not be further apart than:

2 7/16 inches when less than 8/64 inch in thickness.
2 7/16 inches when 8/64 to 12/64 inch in thickness.
2½ inches when 12/64 inch or more in thickness.

The sample shall then be stretched at the same rate until the marks are:

9 inches apart for less than 8/64 inch thickness.
8 inches apart for 8/64 inch to 12/64 inch in thickness.
7 inches apart for 12/64 inch or more in thickness.

before fracture occurs.

The tests to be made at a temperature of between 50 and 100 degrees Fahrenheit on a sample that has not been stretched before the test.

The compound shall be removed from No. 4 wire or smaller in such a manner that the full cross section of the compound is available for test. For sizes larger than No. 4 the sample shall be obtained by cutting the compound toward the center of the wire in order to obtain a segmental section.

The tensile strength of the vulcanized compound shall not be less than 1,000 pounds per square inch. The sample for this test is to be obtained as for the elasticity test.

The vulcanized compound after application shall, after 24 hours immersion in water and before the application of braid or sheath, be subjected to a high potential test for a period of time as follows:

Cables for working pressure from conductor to ground up to 5,000 volts................5 minutes
Cables for working pressure from conductor to ground over 5,000 volts................15 minutes

The test potentials shall be as follows:

TEST POTENTIALS, KILOVOLTS

For 5 minutes test use following values.
For 15 minute test 90% of following values.

Size of Conductor	Thickness of Insulation in 64ths of an inch. 3	4	5	6	7	8	10	12	14	16	18	20
20 B.S.	3.2	4.2	5.2	6.2	7.2	8.2	10.2	12.2	14.2	16.2	18.2	20.2
18	3.4	4.3	5.4	6.4	7.4	8.4	10.3	12.3	14.3	16.3	18.3	20.4
16	3.5	4.6	5.6	6.6	7.6	8.6	10.6	12.6	14.6	16.6	18.6	20.6
14	3.6	4.9	5.9	6.9	7.9	8.9	10.9	12.9	14.9	16.9	18.9	20.9
12	3.6	5.1	6.2	7.4	8.3	9.3	11.3	13.3	15.3	17.3	19.2	21.2
10	3.5	5.2	6.5	7.8	8.7	9.8	11.8	13.8	15.8	17.8	19.7	21.7
8	3.1	5.0	6.8	8.2	9.5	10.8	13.0	15.0	16.9	18.9	20.9	22.8
6		4.8	6.7	8.4	10.0	11.4	13.8	16.0	17.9	19.9	21.9	23.9
4		4.4	6.5	8.4	10.2	11.7	14.5	17.0	19.2	21.2	23.2	25.3
2		4.0	6.1	8.2	10.1	11.9	15.1	18.9	20.5	22.7	24.9	27.0
1			5.8	8.1	10.0	11.9	15.3	18.3	21.0	23.5	25.8	28.1
0			5.6	7.9	9.9	11.8	15.4	18.6	21.5	24.2	26.6	29.0
00			5.2	7.6	9.7	11.7	15.5	18.8	21.9	24.7	27.4	29.9
000			4.9	7.4	9.5	11.6	15.5	19.0	22.3	25.2	28.1	30.8
0000			4.4	7.0	9.2	11.4	15.4	19.1	22.5	25.7	28.7	31.6
250,000 C.M.				6.7	9.0	11.2	15.3	19.2	22.7	26.0	29.1	32.1
500,000				5.0	7.6	10.0	14.5	18.8	22.9	26.7	30.3	- -
750,000					6.5	9.0	13.8	18.3	22.6	26.7	30.6	- -
1,000,000					5.6	8.2	13.1	17.7	22.2	26.5	- -	- -
1,250,000						7.6	12.6	17.3	21.8	26.3	- -	- -
1,500,000						6.9	12.1	16.8	21.4	- -	- -	- -
1,750,000						6.4	11.6	16.4	21.1	- -	- -	- -
2,000,000						5.0	10.3	15.3	20.2	- -	- -	- -

The test potential shall have a frequency not exceeding 100 cycles per second and shall approximate as closely as possible to a sine wave.

The insulation resistance shall be measured immediately after the high potential test and shall be not less than the values given in the following table:

MEGOHM-MILES AT 60 DEGREES FAHR.
Based upon the Constant 3000.

Size of Conductors	Thickness of Insulation in 64ths of an inch. 3	4	5	6	7	8	10	12	14	16	18	20
20 B.S.	1700	2050	2250	2450	2600	2800	3000	3200	3400	3600	3700	3800
18	1550	1850	2100	2250	2400	2550	2800	3050	3200	3550	3500	3650
16	1350	1600	1800	2000	2150	2300	2550	2750	2900	3100	3200	3350
14	1150	1400	1600	1750	1900	2000	2300	2500	2650	2800	2950	3050
12	1000	1200	1400	1550	1700	1800	2050	2250	2400	2550	2700	2850
10	850	1000	1200	1350	1500	1600	1800	2000	2150	2300	2400	2550
8	650	800	950	1100	1250	1300	1550	1650	1800	1950	2050	2150
6	500	650	800	900	1000	1100	1300	1450	1550	1700	1800	1900
4		550	650	750	850	950	1100	1250	1400	1500	1600	1700
2		500	550	650	700	800	950	1100	1200	1300	1400	1500
1			500	575	650	750	850	1000	1100	1200	1300	1350
0			450	525	600	700	800	900	1000	1100	1200	1250
00			400	475	550	650	700	800	950	1000	1100	1200
000			375	450	500	550	650	750	850	950	1000	1100
0000			325	400	450	500	600	700	800	850	950	1000
250,000 C.M.				350	425	475	550	650	750	800	900	950
500,000				275	300	350	425	500	550	600	700	
750,000					250	300	350	400	475	550	600	
1,000,000					225	250	300	350	425	475		
1,250,000						250	275	325	375	425		
1,500,000						225	250	300	350			
1,750,000						200	225	275	325			
2,000,000						150	200	250	275			

The insulation resistance shall be measured after a one minute electrification with a battery having an e. m. f. of not less than 100 and not more than 500 volts and the results corrected to the standard temperature of sixty degrees Farenheit.

The temperature coefficient used in correcting the insulation resistance to the standard temperature of sixty degrees Farenheit, shall be as follows:

The insulation resistance (megohms) at a given temperature shall be reduced to that at 60 deg. Fahr. by dividing by the coefficient corresponding to that temperature.

(Tests shall be made at temperatures within the scope of this table.)

TEMPERATURE COEFFICIENT OF RESISTANCE

Temperature Degrees Fahr.	Coefficient shall not be greater than	Temperature Degrees Fahr.	Coefficient shall not be less than
46	1.44	60	1.000
47	1.41	61	.974
48	1.37	62	.949
49	1.34	63	.925
50	1.30	64	.901
51	1.27	65	.878
52	1.24	66	.855
53	1.20	67	.833
54	1.17	68	.812
55	1.14	69	.791
56	1.11	70	.771
57	1.09	71	.751
58	1.06	72	.732
59	1.03	73	.713
60	1.00	74	.695
		75	.677

Tinning.

Samples of the wire for tinning shall be thoroughly cleaned with one of the reagents named below and immersed in hydrochloric acid of a specific gravity of 1.088 for one minute. It shall be rinsed carefully in clear water and wiped dry with clean waste or rags.

It shall be immersed in a sodium sulphide solution having a specific gravity of 1.142 and containing an excess of sulphur for thirty-two seconds, and wiped dry as before. This cycle of operations shall be repeated until the blackening of the wire becomes clearly visible.

The number of such cycles required to produce a blackening effect shall be noted, and shall represent the measure of efficiency of the tinning. The minimum average values that will be accepted are as follows:

Gauge of Wires B. & S.	No. of Immersions at 60 Degrees F.
No. 18	4
No. 17 to No. 12, inclusive	8
Above No. 12	10

All grease must be carefully and thoroughly cleaned from the wire by the use of one of the following, which are given in order of preference:

Ether, benzine, gasoline, naphtha, caustic alkali solution, hot water and soap.

To avoid testing ends the wire shall be bent into loops having a radius of twelve or fifteen times the diameter of the wire.

The mechanical test for the adhesion shall be made by bending samples around a rod having a diameter equal to four times that of the wire. Any cracking or parting of the coating will be plainly shown by one immersion according to the above test. No sample should show blackening after the mechanical test on immersion for one minute in the sodium sulphide solution only.

The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five seconds. Unless this solution has this effect on the clean copper wire, it is not satisfactory for the tinning test.

After the removal of the wire from the hydrochloric acid, it should be rinsed clean before immersing it in the sulphide.

This wire should be thoroughly rinsed clean of the sulphide before again dipping it in the hydrochloric acid.

Part 2—Inspection.

The Railroad Company's Inspector shall have the privilege of visiting the factory and investigating all stages of the process of manufacture excepting that relating to the preparation of the rubber compound, nor shall he be privileged to inquire into this subject, except as it relates to these specifications, and then only of the proper person as designated by the factory officials.

Manufacturers receiving orders for wire under these specifications shall notify the Testing Department upon receipt of such orders, at the same time advising him the date it is expected to start the manufacture and the approximate date on which it is expected to submit the wire for inspection. When the entire order or part of same is ready for inspection as called for by Section...., the manufacturer will notify the Testing Department, which will send an Inspector to the works. To avoid delays it is recommended that the manufacturer arrange for the inspection date several days before the actual completion of that stage of the manufacture. Upon receiving word from the Testing Department that the inspection date is satisfactory the wire shall be immersed in water so that upon the arrival of the Inspector it shall have been in the water for a period of 24 hours. The temperature of the water during the immersion period is to be approximately the same as when the insulation resistance is measured. Upon the absence of more definite information ten o'clock A. M. shall be taken as the time for the inspection. Failure upon the part of the manufacturer to have the wire immersed for a period of 24 hours preceding the time arranged for the inspection shall be sufficient cause to reject the wire.

The manufacturer shall make all tests called for or necessitated by these specifications in the presence of and to the entire satisfaction of the Inspector, except those relating to the analysis of the rubber compound, which will be made by the Railroad Company. All tests made at the factory shall be at the manufacturer's expense.

The sample of vulcanized rubber compound for chemical analysis shall be taken by the Inspector from any part of the piece submitted for inspection. The length of such sample to be not less than ...... inches in coils of No. .... or smaller.

The Inspector may seal the wire at any stage of the manufacture, and these seals must appear on the wire in its finished state. Loss of seals during the manufacture will be taken as an indication of careless handling in the factory, and shall be cause for rejection of the wire. The application of seals is in no case to be taken as evidence of acceptance, but serves only as identifying marks. The final acceptance shall be on the written authority of the Testing Department. Wire injured in transit to the destination as called for in the order shall be rejected and returned to the factory at the manufacturer's expense, notwithstanding the fact that the wire may previously have been accepted on the written authority of the Testing Department.

Any or all of the above tests may be made at the option of the Inspector at the Laboratory of the Railroad Company.

At any time it is deemed advisable to conduct tests at the Laboratory of the Railroad Company, the results of same will be official. Such tests, however, shall be at the expense of the Railroad Company.

The manufacturer is at liberty to send a representative to witness such tests.

Inspection shall not relieve the manufacturer from the obligation of furnishing perfect material and sound, reliable work. Any unfaithful work or failure to meet the requirements of these specifications that may be discovered by the Railroad Company on or before receipt of the wire, shall be corrected immediately upon request of the Railroad Company, notwithstanding that it may have been overlooked by the Inspector.

HARD-DRAWN COPPER WIRE.

The specifications for hard-drawn copper wire are the same as adopted by the association for Testing Materials, and are printed in the proceedings of this association for year 1909. We are not ready to submit copy of this specification at present time, but same will be ready for the annual convention.

G. B. Colgrove, Chairman,
J. R. Sloan,
A. W. Chambers,
A. J. Farrelly,
J. P. Puette.

Report of Committee on Standards

No official action has been taken on any of the recommendations of your various committees on standards due to the fact that the value of a representative senior active member's vote had not been officially determined.

The question was referred to the Executive Committee at the last annual meeting, and their decision appears as an amendment to our constitution. The recommendation of the committee on train lighting, of the M. C. B., was submitted to letter ballot and was rejected. Through an oversight the report was voted upon as a whole and not by sections.

Your committee therefore presents to you the following recommendations, for standard practice:

1. That each electrically lighted car be provided with a notice giving the following information; that

this notice shall be posted in the Electric Locker:

System
Type of Generator
Type of Regulator
Type of Lamps
Voltage of System
Voltage of Lamps
Number of Cells Storage Battery
Normal charging rate (At charging receptacle)............Amp.
Size of train wires, No. .... B. & S.
Number of train wires (2 or 3)
Capacity of Generator .... Amp.
Setting of Axle Generator .... Amp.
Setting of Auto Switch .... Volts
Setting of Zero Charge Relay .... Volts
Setting of Lamp Regulator .... Volts
Capacity of battery (At 8 Hr. rate) .... Amp. Hrs.
Ampere Load—all lights (lights only)....................Amp.
Axle Pulley .... In. Diam. .... In .Face .... In. Bore
Generator Pulley .... In. Diam. .... In. Face
Pulley Bushing .... In. Diam. of Bore
Length of Belt .... Ft. .... In.
Diagram of connections (showing location, type and ampere capacity of fuses)

2. (a) That all cars operated on head end systems must be equipped with three train lines; that all cars furnished by a foreign road, for service in trains on head end systems must be equipped with either permanent or temporary train lines, and the Standard train line connector and receptacles.

(b) That where train line wires are installed they must be fitted with the standard train line receptacle and connector located as shown on figure one, with connections to battery, dynamo, and jumper, as shown on figure two. If only two wires are used the center connection is to be omitted, and female receptacle marked—NOT FOR USE ON HEAD END SYSTEMS.

3. That batteries as a "set" shall be connected up with positive pole to the right, facing the car, as shown on "Fig. 2."

4. That where double compartment tanks are used, the connections and arrangements of battery terminals are to be as shown on "Fig. 3."

5. (a) That each electrically lighted car, equipped with storage battery boxes, must be provided with one or preferably two charging receptacles of sufficient capacity to carry 65 amperes of current without temperature rise exceeding 15°C., provided with a self closing cover, and terminal connections to receive a standard charging plug.

(b) The standard charging plug and receptacle must be interchangeable with the Anderson type "A."

The positive pole must be connected to the outside annular ring, negative pole to center post.

6. That each electrically lighted car be provided with two 150 ampere fuses close connected to each battery terminal; each fuse to be placed in a separate metal box; these boxes to be located on outside of battery box; the fuses to be so connected that all current passing to or from battery must pass through both of them; the fuse block to have the N. E. C. 150 ampere knife blade type of clip terminal with a clear space of 4 inches between terminals.

7. That each electrically lighted car shall be provided with a switchboard; that on the switchboard there must be mounted switches, fused switches, fuses, or terminals, to completely disconnect the following parts:

a—Train line.
b—Battery.
c—Axle dynamo (where axle dynamo is used)
d—Lamps.

(The axle dynamo terminals to control the positive and negative armature, and positive field of dynamo.)

(The axle dynamo fuses to protect the positive armature, and positive field of dynamo.)

8. That where a main lamp switch is used or where fuses controlling all lamps are used, they shall be so marked in plain letters.

9. The link type of fuse 2½ inches between centers may be used, except for field or individual lighting circuits. If the link type of fuse is used in place of a knife blade type, it must be mounted on a removable support having standard type of knife blade terminal.

10. Where the generator leads are not run in metal conduit a single pole protection either by fuse or equivalent device of approved design may be used (provided that the safety device is located in the lead not connected to the series winding), close connected to the dynamo, and prior to the said lead being secured to the bottom of the car. The above fuse or safety device to be used for emergency service only and to be at least 100% above the capacity of the fuses on the switchboard protecting the same lead.

11. That the following voltages should be used:

(a) 60 volts (nominal) for straight storage and head end systems.

(b) 30 volts (nominal) for straight storage or axle dynamo systems.

12. (a) That storage batteries shall preferably be installed in double compartment tanks; that they should be installed in metal or rubber lined wood tanks, each tank provided with distance pieces, so that a clear space of at least ¾-in. is maintained between sides or bottom of the double compartment tank, and an adjoining tank or sides and bottom of the battery box. (b) Each individual tank, tray or crate, must be marked so as to show ownership of battery.

13. That battery boxes shall have provided in each door, a vent substantially as shown on Fig. 4.

14. That when facing the end of the truck on which axle generator is mounted, the pulley or sprocket shall be on the righthand side.

15. That the rules of fire underwriters shall cover all wiring and installation of electrical equipment in cars.

16. That all wiring under car to the switchboard shall be run in conduits.

17. That a straight pulley seat be provided for the axle pulley. That if a bushing or sleeve be used it must be secured to the axle independent of the pulley. Bushing to have an external diameter of 7½ ins and to be 8½ ins. long, turned straight. That the pulley hub have a uniform internal diameter of 7½ ins., the length of the hub to be 6½ ins., the face of the pulley to be 9 ins. or wider if flangeless, and 8 ins. if flanged. That the generator pulley be flanged, crowned and perforated, and have a 7-in. face.

18. On electrically lighted cars furnished to foreign roads where no agreement is made, a charge of 75 cents per car per day shall be made for use of electric equipment.

19. (a) On electrically lighted foreign cars, where no agreement is made a charge of 35 cents per hour shall be made for labor on electric repairs. (b) That all material used in making repairs to the electrically lighted cars of foreign roads shall be charged at cost.

20. Current for recharging storage batteries to be charged at cost.

21. The type of terminals for reception of fuses to be as follows:

(a) The "Edison" screw shell for individual lamp and fan circuits.

(b) The Ferrule type of clip for axle generator field 1-in. clear space between clips.

(c) The knife blade type of clip terminal for reception of fuses 31 amperes or over, except as noted in Sec. 6.

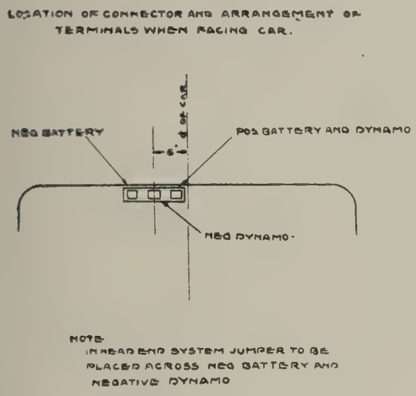


Fig. 1.

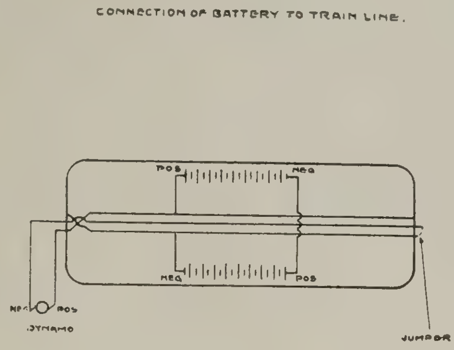


Fig. 2.

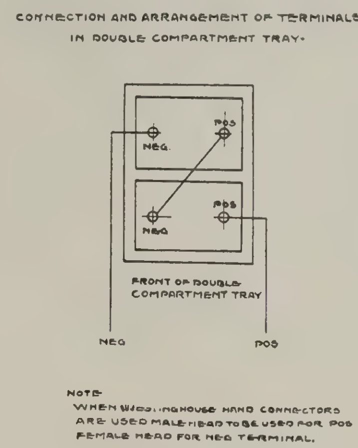


Fig. 3.

(d) The main generator fuse terminal on axle system to have 4-in. clear space between clips.

(e) The battery fuse terminals, close connected to battery under car, to have 4-in. clear space between clips.

(f) On the switch board, the battery, mainlight, and train wire circuits to be each provided with terminals for reception of fuses 2½-in. between centers, having wing nuts or machine screws, with washers for securing fuse or strap.

22. That the suspension for an axle generator must be so designed as to permit the easy removal of pulley or armature.

23. That the storage battery boxes be placed as near as possible to center of the car; that if made of metal, they must have an insulating floor at least 1 in. thick, and inside of box thoroughly painted with an acid resisting compound or paint.

24. All wires at terminals must be marked for identification of polarity.

25. The drop in voltage on car wiring must not exceed 2% between battery and switchboard (full load) and not more than 2% drop between switchboard and any one light outlet, all lights burning.

26. (a) That the style of lamp known as the G. 18½ with short Edison base mounted on globe in such manner that there is a ¼-in. neck between base and globe be used for train lighting. (b) That when larger candle power is required the G. 30 globe should be used for train lighting.

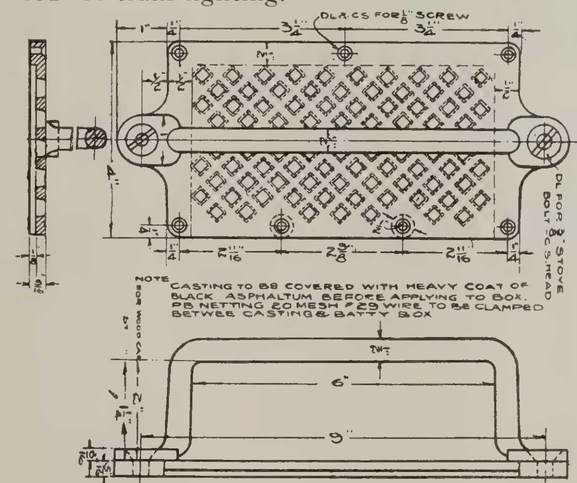


Fig. 4.

27. All parts of the suspension gear or generator, on a new truck, must have at least a clearance of 6 in. above top of rail, and a clearance of at least 3½ in. between any part of the mechanism attached to car body.

D. J. Cartwright, Chairman.
F. R. Frost.
A. J. Collett.
J. R. Sloan.
C. R. Gilman.
A. J. Farrelly.

Report of Committee on Train Lighting Practice

As our Committee has interpreted the subject, the scope of its work covers the investigation of the methods of operation and maintenance of the different systems of electrically lighting trains, the placing before the Association of new developments or changes affecting the systems as a whole and making recommendations of such features that represent best practice. Improvements or introduction of new features in the apparatus itself, have been left to the Committee on Improvements.

Head End Practice.

The greatest extension in the use of the head end system, where special features have been involved, has been its introduction on the Baltimore and Ohio Railroad System, where it has been installed on four of the through trains. Heavy grade conditions restrict the operation of the turbines over several sections of the road, which, in connection with the varying make up of the trains during their runs, has necessitated large battery capacity per train and ability to charge the batteries at any time, regardless of the number of lamps burning. The standard 64 volt system is used with turbine equipments carried in the baggage cars and with five or six sets of 300 ampere hour batteries on a seven car train. Each car, with the exception of the baggage and express cars, is equipped with a lamp voltage regulator. A standard make of regulator, as used in axle lighted service, has been adopted. On

baggage and express cars, on account of the few lamps installed not justifying the cost of a lamp regulator, a resistance is used which is cut in the lamp circuit while the batteries are being charged. A voltage from 66 volts to 85 volts is maintained on the train line, depending upon the amount of charging necessary. Tungsten lamps are used exclusively and an average life of 1200 to 1500 burning hours is being obtained including breakage occurring in shipment, or installation. Special train electricians under the jurisdiction of a chief electrician are used to operate the equipments.

Further extension of the 60 volt system has been made on the C. M. & St. P. Railroad, though none of the other roads operating the 110 volt system have changed to the standard. Inasmuch as, in addition to the adoption of 60 volt as standard voltage for the head end system by this Association, this voltage has been recommended by the Train Lighting Committee of the M. C. B. and will undoubtedly be adopted this year by that Association, it is hoped that the use of the 110 volt systems now in operation will soon be discontinued.

While the recommendations pertaining to head end practice are based on the views of the various engineers connected with the operation and maintenance of this system of train lighting, your Committee realizes that the policies of the managements of different roads, and local conditions, will, in instances, more or less affect carrying them out.

Field for Head End System

For through service the conditions favorable for the use of the head end system are large trains making long runs (at least ten hours) where the operating conditions and make up of the trains are such that the train, instead of the car, is the operating unit.

Equipment

Turbine generator sets exclusively are recommended, and for through service should be located in the baggage car. The number of sets of batteries used depends upon local conditions, but sufficient capacity should be provided to carry the lighting load until the nearest division point is reached, where repairs can be made, or car replaced, in case of disablement of the generating equipment or the turbine car. The batteries should be so distributed that auxiliary light will not be needed while trains are being switched, or for cars dropped or picked up en route which are open to passengers while not connected to the train. The head end system of train lighting has been in use a sufficient length of time to demonstrate fully its reliability with proper equipment and methods of operation. The use of auxiliary lighting other than electricity is therefore not recommended, and only when the system is so operated that this can be done does the Committee consider it on an equitable basis for fair comparison with the other systems of electric lighting.

Steam Hose

Both rubber hose and metallic connections are used for the high pressure steam service between the locomotives and turbine cars. Data available is insufficient to determine definitely the relative reliability and cost of maintenance of the two kinds. Railroads which have used both recommend the all metallic connection as being more reliable and economical, though the results obtained with its use are not entirely satisfactory. The use of position locks on the couplers of the steam connections is recommended. There seems to be, however, considerable room for development of an automatic coupler lock which will be simple and reliable. The Committee suggests that the Association investigate this matter further.

Battery Charging

The charging of batteries en route, as far as possible, is recommended. To insure batteries being kept in proper condition, gravity readings in connection with voltage readings should be taken at terminal stations and accurate records kept of their performance. With the head end system especially, where the charging of the batteries is dependent largely upon the judgment of the operators, the use of ampere hour meters, registering both charge and discharge, is strongly recommended. The ampere hour meter gives not only a ready indication of the condition of the battery, but provides accurate means for determining the amount of charge necessary.

Lamp Voltage Regulator

Where tungsten lamps are used and where it is necessary to do considerable charging of the batteries during the lighting hours, the use of lamp voltage regulators, installed on each car is recommended. The regulators automatically maintain a constant lamp voltage, regardless of the train line or battery voltage, and at the same time do not require any changes in the connection of the standard three wire return loop train line, thus retaining the advantages of this system. The experience of a railroad which has used regulators in connection with its head end system for nearly a year and a half, has shown that their additional cost has been fully justified by the longer lamp life obtained.

Train Electricians

The use of train electricians versus baggagemen to operate the lighting equipment is a question affected greatly by local conditions. In general it is dependent upon the amount of work the duties of the train electricians and of the baggagemen demand, and the extent to which these duties are coincident with respect to time. Where a large number of batteries per train are required or where the train make up of cars supplied with batteries varies considerably during the trip, requiring close attention to the operation of the equipment to keep the batteries in proper shape, the use of train electricians is recommended as best practice. Where baggagemen are used to operate the lighting equipment it is essential that they be trained to handle this class of work competently and that as far as their work is concerned with the operation of the lighting equipment, they come directly under the jurisdiction of the department responsible for the train lighting service.

Axle Lighting Practice

The Drive

During the past year several chain drives have been in practical operation and the members of the committee have been informed that the chain drive has proven itself worthy of our serious thought.

The cost of application, including axle and generator sprockets, is about $50.00 per car as compared with a cost of $28.00 for pulleys and the best quality of belting.

Lubrication

The best method of lubricating the armature shaft of an axle driven generator is yet to be determined; the various methods are as follows:

Metal ring oiler.
Chain ring oiler.
Felt ring oiler.
Wick.
Packed box using waste.
Ball bearings packed with grease.
Grease used in a compression cup.

It would be a material benefit to the members of our Association and a saving of many dollars to our respective roads, that this subject be thoroughly discussed or presented to the Association through the Railway Electrical Engineer. The question of proper lubrication is quite an important one.

Belts

It is best to apply as long a belt as possible which will permit one to trim the ends from time to time, thus affording a more secure fastening for the belt clamp where both ends meet.

The proper belt tension has not been given due consideration by many operating axle equipments, as a result the cost per car month is nearly three times as much on some roads as compared with others.

Pulleys

The generator pulley should be as large in diameter as possible. It is a well known fact that a belt operating over a 12 inch pulley will give nearly 100 per cent more belt life as compared with one operating over a pulley 8 inches in diameter.

Cutting in Speed

Under normal conditions the cutting in speed should be 25 per cent of the maximum train speed. There are no generators built that can be properly regulated or controlled through a ratio greater than one to four. There are many advantages to be gained by operating the armatures at a minimum number of revolutions per minute. You reduce belt speed in feet per minute, get better commutation, less wear on brushes and bearings and reduce the liability of hot boxes.

Suspension

During the past year the majority of the generators have been attached to the truck by the "four point" suspension, the design of which, however, can be improved to prevent the lateral movement of the generator and its support due to the movement of the truck in going over a curve or switch.

Regulation of Generator Output

The carbon pile seems to be the most popular either in series with the field or as a shunt. One manufacturer has developed a rheostat type of regulator operated by a solenoid thus overcoming the objection to an auxiliary motor and yet retaining the advantages of a resistance with a negative coefficient.

Records and Reports

The keeping of an accurate record of the operation of the equipment on the cars is earnestly recommended, that a system of daily reports should be made out by train crews or electricians who may ride the cars.

General

Of the number of features pertaining to train lighting practice which your committee feels could be taken up profitably for investigation by the association is the question of fuses for car lighting service.

From replies received from various engineers who are engaged in electric train lighting work, all report unsatisfactory service from the N. E. C. standard enclosed fuses and with one exception do not favor its use. Troubles which have been experienced with this type of fuses are: Failure to indicate when blown; blowing at current values other than their normal ratings, both above and below; and open circuiting. Most of the engineers favor either the open link type of fuse or some special modification of that type. Your committee would recommend that the Association, through the proper committee, investigate this question specially during the coming year for the purpose of developing a suitable type of fuse which will meet the requirements of car lighting service, with view of having it adopted by the Association as standard for this class of service. It is recommended that the fuse be of such design that it can be used in the same fuse holders as the N. E. C. standard enclosed cartridge fuses of the same capacities.

A. McGary, Chairman.
W. C. Kershaw,
E. A. Van Buskirk,
L. S. Billew,
D. J. Cartwright.

Ventilation

By E. M. CUTTING

During the Association year just closing, or since the last annual convention of Railway Electrical Engineers, the Chairman of the Committee on Ventilation has received from time to time and from various sources a large amount of data on the subject of ventilation in general and car ventilation in particular, and in the preparation of this paper wishes to acknowledge due credit to various gentlemen or concerns responsible for letters received, or published papers appearing in magazines, booklets and leaflets, from which the Chairman has quoted freely when the matter contained therein has been better said than he could have said it himself.

If the rules governing ventilation were as well understood as the principles of electricity, and were there an Ohm to give his law of $C=\frac{E}{R}$—a body of men might be appointed who could agree on what should be recommended, but the great diversity of opinion makes it seem almost impossible to compile a Committee Report and I have, therefore, taken the liberty of submitting a paper as my report, which it is not expected will be concurred in by all members of the Committee, but which, it is hoped, will be of at least some interest and result in some wholesome discussion.

This may appear to be rather revolutionary so far as the regular routine of committee reports is concerned but I feel it is the only thing I can do in the matter on account of the aforementioned great diversity of opinions.

Those to whom credit should be given are Dr. W. A. Evans, Dr. Thos. R. Crowder, Wm. E. Watt, W. H. Lynch, Francis A Bonner, Railroad Editor of the *Chicago Evening Post*, Konrad Meier, contributing to the "Domestic Engineer," Samuel G. Thompson, Assistant Engineer Motive Power Department of the Pennsylvania Railroad, The National Pure Air Association, B. F. Sturtevant Co., B. W. Stowe, F. E. Hutch-

Editor's note:—This paper, written by Mr. E. M. Cutting, Chairman of the Committee on Ventilation, appears in place of the report of that committee. It is not put forward as an expression of the committee, nor are the views expressed necessarily those of the committee.

ison, T. H. Garland, The Burton W. Mudge Company, The Railway Electrical Engineer, and various newspapers and technical journals from which clippings have been cut and sent me without in all cases indicating the newspaper or journal from which such clippings were obtained.

Systems of Car Ventilation

All of the systems at present in use on railroad passenger cars may be grouped under two heads; 1, Natural Systems; 2, Artificial or Mechanical Systems.

The first group make use of the movement of the train to force some of the outside air into the cars, through open deck sash, windows and doors. Others exhaust air from the top of the cars, and where the incoming air is first passed over heating coils in cold weather, the results are very satisfactory when train is moving at not less than 30 miles per hour.

The other group is the Artificial system employing fans to either drive air into the car, or force air out, and possessing some advantages over the Natural System inasmuch as they do not depend upon the motion of the train for their successful operation.

Dr. W. A. Evans, Commissioner of Health of the City of Chicago, has very well stated that "there is no exact knowledge on the subject of ventilation," and a careful perusal of the literature on this subject which I have collected would seem to prove rather conclusively that Dr. Evans is right in his statement, for among the various contributors it is unfortunate that opinions advanced should be at such variance with each other and it is consequently extremely difficult to segregate from this mass of conflicting data any exact rules of ventilation.

Wm. H. Lynch contends "that even if the divergences of view already shown were the only points of disagreement they should be enough to forbid any attempt at all at standardization. The disagreement is too marked and wide to be ignored and the matter too vital to be settled in a onesided way. It would seem that the merest shred of common sense would demand that before standardization should be even remotely suggested there should be some reasonable agreement in this matter."

"The two schools are too far apart to allow that both are right. It may be both are wrong. Who knows? Who is to determine? At least no one faction has any right to put the other faction out of court. There is absolutely but one rational ground upon which it may be reasonably assumed that the truth has been arrived at—it must be a case of general agreement. Make it unanimous, or drop it."

Dr. Evans says that "In Chicago 31,000 people die each year; 10,000 die from diseases due to bad air. When we compare the 268 dying of typhoid fever with this 10,000, we realize the importance of good air. The harm of bad air is due in part to air-borne infections, say, colds, a parallel with typhoid fever; it is due in part to lowered resistance, the same principle as in the collateral harm of polluted water. Therefore we must fight and work for better air-conditions than now prevail. It is not enough to keep our standards and our practices from slipping back. It is necessary that they should advance.

High Temperatures Injurious.

"Yesterday I sat in a large room as one of an audience of 200. The wall thermometer registered 76 deg. The air was introduced at the ceiling and taken out at the floor. The audience was "gappy," "yawny," inattentive, mentally sluggish, and felt oppressed, I think: at least one did. The air was morgue-like in its stillness. That situation would have been greatly improved by some fans agitating the air and supplying currents to clean out the breathing zones and to reduce the aerial envelopes from 90 to 76 deg.; not perfect, but an improvement."

Dr. Watts states that "Heating the air damages it. In the first place air that is to be breathed or to be permitted to come into contact with the skin of man is devitalized by heat. The warmer you make it the worse it is.

"Heating the air destroys the humidity. Not that the steam is destroyed by heat, but it takes more steam to satisfy warm space than cold. Steam goes the contrary way from other gases when heated and contracts enormously. It takes 22 times as much steam to make air right at 70 deg. as at 0 deg."

Konrad Meier says that "According to Fluegge, the proper attention to room temperature is hardly second in importance to the benefits of ventilation as generally accepted. He has demonstrated, that overheating is just as injurious, if not more so, than the effect of ordinary foulness of air due to lack of renewal. He explains this through heat congestion, caused by decreased emission from the human body, with a consequent disturbance of certain functions. It may be held at first thought, that summer heat would be equally, if not more injurious, but the conditions are distinctly different. Lighter clothing and freer air circulation usually allow of much greater heat emission by evaporation, except in the hottest and sultriest weather, which is known to be a tax on vitality even for short periods. In crowded, overheated, though ventilated rooms, with the occupants close together, keeping each other warm by their own radiation, and wearing heavier clothing, the heat emission from the human body is very much reduced.

"It is naturally difficult to determine the relative bearing of foulness and of overheating, each depending so much on the degree and also on humidity, but the fact remains that overheating has been shown to be injurious in itself and is apt to be more so when combined with foul air, humidity and with pollution through unsanitary heating apparatus."

An unknown writer states that "It is amazing that the medical profession has made so little therapeutic use of cold producing machinery, as it is many years since it was discovered that there was some mysterious therapeutic virtue in the breathing of cold air.

"Consumptives, for instance, were found to improve in winter but not in summer, and they made extraordinary progress toward recovery where the temperature was far below zero F., while in hot climates the rapid mortality is dreadful.

"Then came the startling discovery that in many respiratory diseases, particularly the pneumonias of children, cold air was almost a specific even when both lungs were greatly involved and death was certain if the patient was kept indoors in a warm room.

"In the winter we rig up rooms on the roof or veranda for the benefit of the cold, but in summer we hold up our hands helplessly and let the sick die instead of creating the cold air they need. We give them cold storage in the morgue after they are dead instead of keeping them alive by it.

"There is no earthly reason for this helplessness, when it is such a simple matter to cool the air of hospitals. All that is needed is a steam coil or radiator in which cold brine circulates instead of hot water. Instead of radiating heat it is an absorber, and the air forced around the pipes may be cooled to any required degree."

From an editorial in the San Francisco "Chronicle"

we read that "all over the country Red Cross seals have been sold to raise a fund to aid in the fight against the 'great white plague.' Much of the good which might be accomplished in this and other ways, however, is lost because of the habit so many persons have of keeping their windows closed. We are as a people loud in our praise of fresh air—of the invigorating qualities of ozone—but most of us take good care to breathe instead carbon dioxide. The old tradition of the danger of a draft persists with us, and we keep the windows shut as a measure of supposed precaution against colds.

"A young Cambridge physician, writing in a current medical publication, puts the case in this way: 'We shall never really get the upper hand of the 'white plague,'" he says, "'not with our anti-spitting crusades, nor our sanatoriums, nor our outdoor schools, nor our campaign of popular education, until as a people we are willing to ventilate our houses with real air by day and by night. It is appalling to think how many intelligent persons, large contributors to the anti-tuberculosis societies, still think that a room which had the windows opened for an hour in the morning is quite fresh enough for two persons to sleep the night through in without disturbing the window sash, or who feel that a capful of "night air" introduced through the modifying warmth of a room adjoining the sleeper is all that a discreet disciple of the fresh-air cure need be expected to undergo. No, we shall never root out the plague till we get at the last self-coddler with his head under the bedclothes.'

"The Cambridge doctor might have gone further and spoken of the close business offices and workshops, as well as the stuffy bedrooms. No one who has occasion to visit different business places during the daytime can fail to notice that in the majority of them the windows are closed. Occasionally a 'fresh air fiend' is found, sitting at his desk with the breeze from outdoors ruffling the papers on it and giving him zest for increased work, but he is in a pitiful minority.

"As for the closed bedchamber window, it is almost universal. Let anyone who doubts pick out, say, a large apartment house and on a moderately cold night observe how many windows are tightly closed. Two or three may be lowered a hair's breadth from the top, and one or two may be pushed up a few inches from the bottom. The others are shut and whatever air from outside gets into them has to sneak in through crevices due to defective construction."

Strange as it may seem little real progress has been made in the science of ventilation during the past 200 years and even as late as 1907 it was asserted that there were not a dozen private houses in Chicago that were scientifically ventilated and in all probability the conditions are on the average little better now than they were then.

However, thanks to the fact that passenger train cars are in the main designed and operated by various mechanical experts employed by railroads the problem of car ventilation, even though more difficult of solution than that of houses, will no doubt be accomplished with a fair degree of satisfaction long before much improvement is made in the average dwelling.

One person in ten in the United States dies of consumption, and in the national war now being waged against the plague, fresh air is recognized as the best preventive and the greatest curative factor.

The above being true, it is of the utmost importance that fresh air should invariably be supplied all cars used for the transportation of human beings and the great question for discussion at this time is that of fixing on some detail or some fundamental principles which will afford the desired fresh air properly cooled or heated to suit the convenience of the passengers.

Pennsylvania Railroad Car Ventilation.

Although authorities differ so widely in the matter of how this is to be accomplished it appears to be the consensus of opinion that the bad air can most easily be removed from the tops of the cars but with the exception of one notable instance little, if any, provision is made for the admission of air to the cars except through the opening of windows and doors or the leakage around windows and doors when same are closed. The exception referred to is that in service on several of the cars on the Pennsylvania Railroad and a description of the essential parts of the system is as follows, quoted in part from a paper by S. G. Thompson read before the Western Railway Club:

"The intake hood, vertical and horizontal air ducts, and the heating ducts and pipes form an independent system on each side of the car, which can be operated separately or together. The intake hoods are located at opposite corners of the cars on the roof, close to the upper deck, where they will catch the least amount of dust, cinders, etc., and the openings are covered with fine wire gauze to exclude the cinders. The hood contains a flap valve so arranged that the air has a free passage into the down-take in the direction in which the car is moving and the valve is set for the proper direction by the trainmen and is operated from the inside of the car, as is also a butterfly valve located in the down-take, which is used to exclude foul air and smoke whenever necessary, as for instance when going through tunnels."

"The air passages or ducts between the floors and sills of the car are made by removing the cross bracing in the wooden cars and these ducts must be cleaned occasionally for removal of cinders and heavy particles of dust. The steam pipes in the car are boxed in for their full length and openings are cut through the floor to the air ducts below and from the sides of the steam heat pipe boxing, galvanized iron sheet metal pipes 8 or 10 inches in diameter extend almost out to the aisle under each seat.

"There are several Globe Ventilators arranged along the center line of the upper deck and the deck sash in the car are tight and immovable.

"The speed of the train forces the air into the hood on top of the car and down the intake boxing to the air ducts where it is divided as it passes through the openings in the floor to the steam pipe duct and is again divided as it circulates around the heating pipes and passes to the sheet metal pipes leading to the aisles under each seat, the warmed and vitiated air rising and passing out of the exhaust ventilators at the top.

"When there is neither heat nor light in the car it is not expected that proper ventilation will be furnished by this system and particularly when the car is standing still and under such circumstances windows may be opened at the pleasure of the passengers."

Mr. Wm. H. Lynch has also invented various special ventilating apparatus for application to car windows of cars already built, or which can be built into new cars, the principle of which is in a general way to screen the dirt and dust from the air before it enters the car and there are shutters on this screen which are under the control of each individual passenger, which is a feature very much to be desired as against the throwing open of large windows, which, while satisfying passenger controlling the window are never-

theless almost invariably the cause of discomfort to other passengers seated behind.

Investigation of Dr. Crowder.

It appears from Dr. Crowder's exhaustive study of the ventilation of sleeping cars that the present situation with regard to such cars is very much improved over what it was before the application of exhaust ventilators, and that if there is any discomfort it is more probably due to the phenomenon known as heat stagnation rather than to excessive amount of CO_2 content.

Mr. Francis A. Bonner, Railroad Editor of the *Chicago Evening Post*, has written a very able criticism or perhaps more properly speaking, an appreciation of Dr. Crowder's work which is quoted in part as follows:

"That the railroads today are witnessing their first marked revolution in standard of car ventilation is the resultant of two component forces; a widespread and growing interest in the subject of pure air supply and a striking advance in application of efficiency idea. From the standpoint of ventilation, the colonial stage which lumbered between New York and Philadelphia in two days was as efficient a machine as the ordinary railway car of today, despite the marvelous span of invention and progress since the days of the stage coach."

"When 3 or 4 years ago Dr. Crowder of Chicago began on Pullman cars the first exhaustive investigation ever undertaken in this country of air supply in railway vehicles he was fully prepared to find results entirely different from those actually met as it was found that the air of the modern Pullman sleeper was, and is, very much better than might have been expected."

A great number of tests show that there is not such a great difference in the actual purity of the air as between the upper and lower berths and the theory is advanced that in all probability the discomfort experienced by some passengers occupying lower berths is due largely to the imagination, for, such passengers accustomed to sleeping in ordinary bedrooms feel a sense of oppression and stuffiness on account of the very small space, whereas with the exhaust ventilators which are a feature of almost every Pullman car at this time the leakage around the windows even when closed, really produces a sufficiently frequent change of air to make the lower berths quite as well, if not better, ventilated than many ordinary bedrooms where windows and doors are kept tightly closed all night. That the imagination does play us tricks is illustrated by the experience of a couple who occupied a strange room one night, where one of the party complained of suffocation and there being no convenient light, groped around in the dark to locate the window, and finding a sash with glass and being unable to open it, broke the glass and was immediately relieved, whereas the other party complained of a draft and began to catch cold. In the morning it was found that the broken glass was merely the front of a bookcase and had no connection with the outside air.

In all tests made by Dr. Crowder and his assistants it was shown that with cars equipped with exhaust ventilators there was some short circuiting of air. That is the measured amount of air leaving the exhaust exceeded the computed amount furnished the breathing zone, showing that some of the air entered too high in the car to benefit the passengers, but on the other hand furnished a greatly increased air supply and a much steadier air flow than in cars not so equipped.

The surprising increase in air supply to berths in a modern standard Pullman sleeper due to steady suction of air through the exhausts was the most striking result secured in the tests and it should be understood in all these tests all doors and windows were closed although, of course, windows can be opened at the foot of berths when desired by passengers.

Mr. Bonner goes on further to say that our sensations are absolutely untrustworthy as an indication of the amount of air being brought to us, which was another interesting point brought out by the tests. Chiefly heat stagnation and not actual presence of carbon dioxide is the cause of most feelings of "stuffiness."

The most marked instance of offensiveness found was in a day coach, the atmosphere of which was shown to be so chemically pure as to be almost ideal but the car was overheated and full of uncleanly people, and on the other hand perfect comfort was sometimes found with the highest chemical impurity.

To carry away body heat with a constant current of air was shown to be one of the greatest requisites for comfort. Fan motors and open windows do this in summer time and in the exhaust system of ventilation has been found the needed constant air motion or change in the closed car.

It would, therefore, seem that there is no question but what some form of exhaust is absolutely necessary at the top of passenger train cars and that the manner of admitting pure air is a matter which will have to receive considerable thought, study, experiment and discussion before any standard can be determined upon, and as Mr. Lynch so ably states, it would be folly to attempt to fix upon standards when there yet remains so much to be done in determining such standards, and as it has been pretty clearly demonstrated that the absence of appreciable air currents is responsible for much of the discomfort it would appear necessary in addition to providing adequate exhausts and intakes, to also install fans to furnish air currents to penetrate or break up the aerial envelope which surrounds the human body, thus relieving the sensation of stuffiness or closeness. It seems almost impossible to discuss the matter of ventilation without touching on the subject of heating of cars as there is no doubt that much of the discomfort, particularly in cold weather, is due, in a large measure, to overheating for the fact remains that overheating has been shown to be injurious in itself, and the open air school work in Chicago and also the cold room experiments have demonstrated that it might be possible by a proper system of education to accustom passengers to a considerably less degree of heat than some of them now demand.

ELECTRIC HEADLIGHT POSSIBILITIES.

The decided advantages of an electric headlight are now so well established that the eventual replacement of all oil headlights is practically a certainty. There are today in the United States about 60,000 steam locomotives of which about 15,000, or one-fourth, are equipped with electric headlights. Several large railways which have hitherto shunned the electric headlight or used it only on their fast trains are now experimenting with a view to adopting it for all their locomotives. In making this investigation they consider not only the turbo-generator arc headlight with reflector, which is the type almost exclusively used so far, but also the arc lamp with a bull's eye lens and no reflector and the incandescent lamp operated by storage batteries. The double-base incandescent lamp with two filaments arranged in parallel in the same bulb is especially adapted to the latter type.

Latest Electrical Moulded Insulations

In the Light of Science and Necessary Precaution

By KURT R. STERNBERG

Samuel Crothers said:

"I take great comfort in the thought that the world is still unfinished and that what we see lying around us is not the completed product, but only the raw material. And this consolation rises into positive cheer when I learn that there is a chance for us to take a hand in the creative work. It matters very little at this stage of the proceedings whether things are good or bad. The question for us is, what is the best use to which we can put them?"

If we will apply Crothers' words to ourselves, and our chosen profession, we must admit that electrical science and its knowledge is still in an unfinished state and is not a completed product. All of us are earnestly striving to further its development.

My subject is one of infinite complexity and difficulty.

Perhaps I shall fall short of meeting the expectations so kindly expressed to me. I may lack the skill to express the many thoughts which result from years of study in moulded electrical insulations, but I have abundant material. If I had the strength and you had the patience, I could stand here and talk to you about it and its various aspects and under its various sidelights and with its collateral relations from now until morning.

My thought, then, has been, in attempting to address you here on latest moulded electrical insulations in the light of science and necessary precaution, to keep within the bounds of simplicity, to attempt to eliminate many discussions, or branches of discussions as yet academic, and so far as lies within me to draw your attention to some practical sides of this question, and by a process of elimination attempt to reach at least one or two fundamental and rather important conclusions.

I am convinced that, generally speaking, too little attention is paid to electrical insulations We have learned that insulation means to manufacture an insulator or a non-conductor of electricity so placed as to insulate a body.

I am sorry to state that in many cases the question of correct insulation, which really and safely insulates wherever applied, is given only secondary importance and is often considered from a monetary standpoint only, that is, with the purpose in view to get the cheapest insulation, and is in such cases considered a matter of minor weight. It is sometimes neglected altogether.

Negligence, as viewed by law writers of a hundred or more years ago, and as viewed today, is in the nature of a crime. Negligence is called a quasi crime by those who wish to speak in legal parlance.

Physicians have found it necessary to become ear, throat or eye specialists, and so forth, and frankly admit that no one physician has the extensive knowledge of knowing how to treat the entire human body and its ailments successfully. Should we then not do likewise, and frankly admit that no one electrical engineer exists who is able to fully cover the entire field of practical electrical science?

We know that this is an age of specialists. I am a specialist in the electrical field, a practical manufacturer of moulded electrical insulation, and state from experience that I believe insulation **ought to be taught at colleges in a special course, or in a series of lectures covering this subject.** But these lectures must not be based upon general knowledge of insulation alone. Such a course is only complete if the student knows something regarding the manufacture and composition of electrical insulation for various purposes. This knowledge can be best gained by working hand in hand with an engineer of electrical insulation. It might help a great deal if the lecturer could place himself in communication with a practical manufacturer of insulation and try, if possible, to get access to factories making electrical insulation, for the purpose of taking the student into such a factory, and then, going over the subject with the man in charge, studying right there the practical side of this important problem, and, if possible, asking him to prepare insulations for a special part. There might arise some difficulty in getting permission to go into such a factory. In such a case, of if the college is too far away from the manufacturer, it might be wise to ask the man in charge of such a factory to come to the college from time to time and, though a little handicapped by lack of machinery, his practical knowledge, if submitted during a lecture to the student, will help the cause a lot. If this can be done, a great step forward is made. It means helping to use electricity more intelligently and to make it a safer appliance, preventing loss of lives and loss by fire or explosion through the lack of suitable and scientifically applied electrical insulation.

Does the electrical engineer go deep enough into his only safeguard, the insulation? I venture to state that this is done very rarely indeed.

If you would visit with me at my works or with others at their works, adapted for the manufacture of moulded electrical insulations, and look over the blueprints which are received so often, you would quickly understand, when taking the matter from the factory standpoint, and glancing over the possibilities and impossibilities which confront the manufacturer, why I make these statements.

If you will study the possibilities, or limits, of moulded insulation, together with commercial limits, as to costs, etc., at the factory, or with help of the factory, you will find what an immense amount of help you can give the manufacturer, and consequently yourselves, and the art in general. The engineer will learn that with a better knowledge of possibilities for practical success in electrical insulation, he can save himself a lot of unnecessary labor and be in a better position to order drawings made which will help the manufacturer to turn out a good article.

In many cases where manufacturers of electrical apparatus wanted special insulation suitable to their needs and could not find it, they have started their own insulation works, and by hard study and a large outlay of money have succeeded in getting insulation which fills their own wants. In such cases no outside help is needed, as the man in charge of that department will naturally work out his own problems.

Regarding manufacturers who have started their own insulation department, and by careful study are in a position to apply correct insulation to their own wants, I would say that their insulations are for special purposes, and while this is a step forward, it does not help much, because it cannot be purchased in the open market. They only help themselves to get a correct insulation suitable to their needs. We need an insulation which can be bought by small and large manufacturers alike, and in the open market. Do not believe that I make this statement out of jealousy. The manufacturers of electrical insulation will always have work to do. It reminds me of the story of a jeweler in New York City. They have, as you know, a big clock on the Metropolitan tower, striking the time every fifteen minutes, loud enough to be heard ten miles. The jeweler, not knowing human nature, complained in a newspaper article, because he thought nobody would purchase a watch, as they could tell the time by the clock, but the fact was, that everybody wanted a watch so as to tell if the clock was right.

There are very few manufacturers of electrical appliances, though, who are able or fortunate enough to establish their own department of electrical insulation. If that should be your case, let the practical manufacturer, like the physician, advise you, and let him help you to work out your problems. You can only gain and safeguard yourself by doing so.

Manufacturers of insulations who offer their advice and suggestions after receiving blue-prints are often misunderstood, if they suggest corrections without being asked to do so. I may state right here that I have lost a customer by calling his attention to the impractical way in which his blue-print read for insulation purposes. I advised him to simplify the print. It would have meant money in his pocket and a better, serviceable article. I received the following answer instead of an expression of thanks:

"We are extremely sorry that you are unable to read our blue-print intelligently, but we can hardly be blamed for this. We feel as though we have a very efficient corps of draftsmen and can see no reason why some of your mechanical men could not read our blue-print."

Now, gentlemen, you see this customer doubted our ability to read the blue-print. That was not the point nor the fact. I admit that the blue-print was a fine piece of the drawing art, but it was impractical for insulation purposes as far as the manufacturer was concerned. You may note from the contents of the letter that this particular firm left the mater of constructing specifications for electrical moulded insulations to their draftsman, and did not understand my warning, and thought that I was unable to read their blue-print or meant to criticise their draftsman.

If the engineer in charge of this work had studied the possibilities of electrical moulded insulation, his draftsman would have never made this drawing, because the party in charge would have known that his device was not correctly constructed to permit the maker of insulations to do his work right; or his orders to the draftsman would have been changed, so as to comply with needed efficiency of the insulation, to keep within the commercial possibilities of the manufacturer.

In many cases the purchasing agent of a large firm is expected to buy everything, from a pin to high-class electrical machinery and insulations. He depends mostly upon the instructions of the engineers. He tries to grasp this instruction, and I am sorry to state that in many cases it is almost useless for the manufacturer of insulations to argue with the purchasing agent, trying to have him modify his wants to the mechanical and practical needs, within the reach of the manufacturer of insulations. The remedy is clearly within the jurisdiction of the engineer in charge, taking it for granted that he gives the question of insulation the proper attention. But to be able to do this the party in charge must have the proper training regarding insulations himself.

I quite often invite purchasing agents, as well as electrical engineers and men in charge of large firms, men interested in engineering problems, such as so often confront you, to pay me a visit at my works. This is not done to get their orders or from any other selfish standpoint. Quite on the contrary. I saw the necessity of showing these men, by drawings, dies and machinery, some important points. I even explained the so-called secret processes, as far as I could go, and as far as they could justly expect such an illustration from a manufacturer. I wanted to show them what could be done, and what could not be done. I wanted to make them see the limits of the art, even if I had to give away a part of the results of my study. Very few gentlemen paid me visits, but I am proud to say that in two important cases constructing engineers, after they had called upon me, saved thousands of dollars, and received better insulation by changing their designs and making them suitable for practical insulation purposes.

In some other instances I was looked upon as a salesman who was after the trade. I was politely thanked—that was all.

Again, in cases where I talked to the engineer in charge he weighed my German accent, together with the matter of insulation, which was of secondary importance to him, and I was made to feel how big he was and how small the matter which I laid before him.

You, gentlemen, want to safeguard your inventions, your machines and devices, safeguard your life and the lives and property of others. Therefore, you must look in deep earnest into the problem of proper insulations, and you must include *practical study of insulations in your calendar as one of the foremost themes.* You must work hand in hand with the parties who are successful specialists in such branches of electrical insulations, and who have made manufacturing of high-class electrical practical insulation *their life work.*

I will now take up with you, from my own knowledge and some data gathered together from Karl Wernicke's little book, "Die Isoliermittel der Electrotechnik," the matter of "Latest Moulded Electrical Insulations." Naturally, I have to leave out entirely insulations which are applied onto wire by coating this wire, or which are applied in a liquid or cement form, as my theme reads "Moulded Insulations." There are some electricians to whom all insulations look alike. It reminds me of a story I once heard. A teacher, in an effort to make the pupil more careful in the use of words, stated about the children of a neighbor, "Jim and Sam look very much alike, especially Jim." Now moulded insulations are not alike by any means. They differ like night and day.

In 1846 Werner Siemens, of Berlin, Germany, discovered the non-conducting properties of gutta-percha. The result was that in 1851 there was laid across the English channel from Dover to Cape Grisnez a cable twenty-four miles long, consisting of four copper wires, insulated by gutta-percha, covered with

tarred yarn and protected by an outer covering of galvanized iron wires. This was one of the most important steps in the advance of insulation.

In this paper I cannot take up electrical insulations which cannot be moulded, such as wood, fibre, marble, slate, mica, impregnated paper, etc., but under this head really appear the following insulations:

Porcelain, Rubber, Glass, so-called Iron Rubber, Isolast, Festonit, Vulcabeston, Stabilit, Tenacit, Ambroin, Eburin, Adit, Vulkanasbest, German Cornit, Vulcoasbest, Pyrostat, Vitrit, Asbestoscement, Asolit, Fermit, Gummon, Galalith (the Greek word for milk stone), Pulvolit, Rhadoonit, Asbestos Wood, Presspan, Leatheroid, Pilit, and to a certain extent Lavite, though this is too brittle for moulding purposes. We also include all shellac and mica shellac compositions, certain lacquers, Sternoid, Bakelite and Stern-Condensite.

Hard Rubber is a very good moulded electrical insulation. It has high dielectric resistance and sufficient mechanical strength, can be easily worked, cut, sawed, etc., and can be polished very nicely, but hard rubber has some properties which make it impossible for use in certain cases. It is not heat-proof, but softens at about 70° C., will flow at 80° C., is not fireproof in the demands of the Fire Underwriters, and is excluded by them wherever danger of fire is a possibility. It should not be used for single and double petticoat rings, as it expands when warmed up. It also breaks down by its own fatigue and shows age quickly, as air, as well as heat, influences it. The brilliant black which it shows first slowly changes to an olive green. This is due to sulphur which is used while vulcanizing hard rubber and which cannot be bound sufficiently during the process of vulcanization.

The price of hard rubber is high, and due to this fact and reasons just stated many chemists have tried to invent good rubber substitutes. I read in "Hygiene and Industry," a German paper, dated February 5, 1911, a very interesting article. This article says:

"The dye factories, 'vorm. Fr. Bayer & Co., A. G.,' Elberfield, in Germany, have been and are still working on a process of making artificial rubber synthetically. The main question at first is to make the isophren, the proper 'rubber producer,' which may be separated easily from the natural rubber. It has been found that this may be obtained from vapors of turpentine passing through red-hot iron tubes. In scientific circles, however, the opinion predominates that turpentine in itself is a pretty dear product, and ought to be replaced by a cheaper material. According to a new process, invented lately by Dr. A. Pleinemann, a mixture of azetylen and enthylen is heated to a temperature of red heat. Thus a new stuff is formed, which is transformed by methylchloride into isophren, the essential constituent of india rubber. This new process, however, has not been developed sufficiently as yet for any industrial application. Nevertheless, it must be noticed that azetylen is more suitable for making artificial rubber than turpentine, the latter being more or less a product of speculation. Azetylen is produced at present on a large scale, whereas turpentine is subjected to international speculation, the market being especially high last year. After all, however, it looks as if the German scientists will succeed eventually in making artificial rubber fit to be used in the industry, thus freeing themselves from the 'India-rubber yoke.'"

As a rubber substitute, here and abroad, some manufacturers are using shellac as a binder, with fillers such as ground mica, cotton, asbestos and others, with coloring as wanted. These make good insulations, but soften at comparatively low temperatures, and are always brittle. These insulations are made in this country by many firms who are striving to do the best, meeting certain commercial conditions, and some of them have succeeded to get upon the market insulations based upon shellac of good merits.

Porcelain is a very good insulation material. It is of high dielectric resistance, of unlimited service record, and is fireproof, but it is very brittle. No metal parts can be moulded into it, neither can it be moulded accurately enough to dimensions for certain purposes.

The so-called **Iron Gummi** or **Iron Hard Rubber** is made from gutta-percha by the General Electric Co. and the United Isolatoren-Werke in Berlin, and withstands 100° C., at least, but it is not as good so far as its dielectric resistance is concerned. This dielectric resistance was tested up to 88,000 volts at a thickness of 5 mm. Hard rubber of the same size and thickness was found to withstand 97,000 volts.

Isolast is made also from gutta-percha, but is more heat-proof. It is made by Dr. Heinrich Traun & Sons, and has less dielectric resistance than iron gummi. A plate of 5 mm. was pierced at 79,000 volts, but it can be worked nicely.

Vulkanasbest is made by the General Electric Co. in Germany and is mostly a mixture of asbestos fibre with gutta-percha. The asbestos is dried so that it is very little hygroscopic, the gutta-percha is cut with benzine and a dough is made of this binder, together with the asbestos, and worked under pressure and heat.

Stabilit is also made by the General Electric Co. in Germany and is the strongest German insulation material, but it takes the temper out of the steel, as it is very hard to work. It is also not exact as to size. It is made in red, brown, black and gray colors.

Tenacit is also an invention of the same company and is used on telephone and telegraph parts. It is a very good insulator, but it does not present a good finish. It is made in quality A, B, C and D, of which qualities C is most interesting, as it resists all climatic influences.

Ambroin is made by the United Isolatoren-Werke in Berlin. Silicate of sodium and asbestos, copals, etc., by the adding of alcohol, are made to a dough, mixed in mixing machines, placed onto tin plates and these plates are put in a vacuum oven, while on the tins, until the alcohol has evaporated. A powder is then made of these dry cakes and pressed up in heated moulds under high pressure. This gives a very good insulation, but it is somewhat hygroscopic.

Eburin is made by the Street Railway Company in Berlin. They use infusorial earth, asbestos or cotton, and gums, manufactured by thoroughly mixing and then pressing it into shape in steel forms. Eburin is not hygroscopic, is very good against influences of climatic conditions, and as it is also very strong, can be used for overhead material very nicely. It presents a very good appearance. It is is not heat-proof.

The other materials like Adit, German Cornit, Vulcoasbest, Festonit, Pyrostat, Vitrit, Asbestoscement, Asolit and Fermit are also well-known insulation materials used for electrical moulded insulation, and prominent in making them are Adt Bros., in Enshein; H. Weidmann, in Rappersweil, Switzerland; the Isola-Werke, in Oerlikon-Zurich; The Vacuum-Pressgut-Ges, Berlin.

We further have **Galalith,** named after the Greek word for milk stone. Galalith is made of skimmed milk, from which the water parts are extracted, and which then is subjected to a heating process, so that we get the stone-like product casein, which is treated in an acid bath. This gives an amber-looking mixture, which is placed into forms by pressing, and is used more for combs than for moulded electrical insulation, as it is very highly hygroscopic and, therefore, not very good for certain electrical insulation purposes. It can be worked by tools and bent into forms after softening it in water. When worked with formaldehyde some better results have been obtained.

Pulvolit is very strong, but its dielectric resistance is not high; it withstands heat up to 100° C. A plate of 8 mm. thickness was pierced at 20,000 volts. Pulvolit is made by the Isolatoren-Werke Pulvolit, Frankfort-on-the-Main, recently taken over by the Isolatoren-Werke, of Munchen, Germany.

Rhadoonit is made by the Rhadoonit Works in Dohna, near Dresden, in Saxony, and is said to contain four-fifths minerals, to which under pressure and under sulphur vapors a binder partly of organic, partly of inorganic nature, is added. This mixture is pressed in hydraulic vulcanizing presses under high pressure and heat. It is very heavy, between 20 per cent and 25 per cent heavier than marble.

Impregnated Paper cartons are hardly to be mentioned under this heading, though they are used for spool boxes and other parts quite often. They are pressed into these special shapes.

Presspan is used for insulation of material in transformers, and is mechanically very strong. It can be bent, and comes in light brown, dark brown and medium brown colors. It is impregnated and boiled in clean linseed oil thinned by benzine. The time required for boiling varies at thickness from 0.5 mm. of 12 hours to thickness of 1 mm. of 18 hours.

Leatheroid is similar to Presspan, but is mechanically stronger.

Pilit is made by Meyer Zimmerli in Zurich and Maynberg. It is said that selected wool is used in the Pilit with a mixture of ozakarit, wax, kalophonium and linseed oil. The most important quality of Pilit is said to be that it is flexible.

Gummon is the invention of Carl Mueller, of Munchen-Grafelfing, Germany. His patents have been bought up in this country and the material which he invented is made by the Hemming Mfg. Company, of New Jersey. The Isolatoren-Werke, of Munchen, Grafelfing, have followed up Mueller's patent for the last eight years and are making "Gummon" originally based upon the Mueller patent. They claim that their Gummon is an improvement over the original Mueller patent and have sold their secret processes to the Dickinson Manufacturing Company, of Springfield, Mass. This company is making the Gummon, as manufactured by the Isolatoren-Werke in Munchen, Germany, in this country. It is heat-proof up to 700° F., can be moulded in the cold way, that is, without heating the dies, and is cured in an oven in a slow rising process up to about 500° F., and is then cooled and presents a finished appearance after having been subjected to a polishing. Gummon is approved by the Underwriters' Laboratories, Inc., of Chicago.

Sternoid, named after the writer, is also approved by the Underwriters' Laboratories, Inc., under same heading and on the same card, and tests have proven that Sternoid is of high dielectric resistance and lighter than Gummon. The specific weight of Gummon is higher and it can not very well be sawed or drilled, without taking the temper out of the steel. Mueller's invention Gummon made here in the United States by the Hemming Mfg. Co., the Gummon of the Isolatoren-Werke made by the Dickinson Manufacturing Co., of this country, also Sternoid, present important improvements over insulations used before these inventions were placed upon the market.

I do not intend to say much regarding manufacturers of mica-shellac insulations. Several large firms, as stated previously, have succeeded in making first-class insulation for their own use. In this connection I like to mention the following firms: General Electric Company, Ohio Brass Company, Cutler-Hammer Manufacturing Co.

Moulded Insulation Sockets.

The Johns-Pratt Company of Hartford, Conn., is an important company in the insulation line. Their vulcabeston, their Monarch composition and others have taken a leading place in the manufacture of good insulation materials. They consist mostly of high-grade vulcanized rubber and asbestos pressed and cured in their own manner under appliances of heat and pressure.

Manufacturers of rubber substitutes well worth mentioning, are the Anderson Co., Boonton Rubber Co., Henry Cole Co., Duranoid Button Co., Electrose Mfg. Co., General Insulating Co., Goodrich Co., Scranton Button Co.,Auburn Button Co., Hemming Mfg. Co., Lovering Mfg. Co., MacAllen Co., Siemon Hard Rubber Corp., and the Dickinson Manufacturing Co. All of these are honestly striving to further the art.

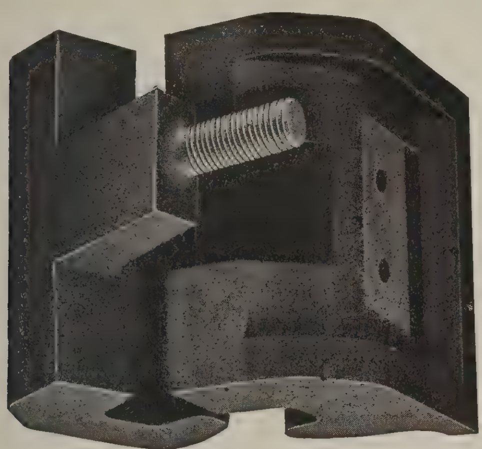
Various Designs in Moulded Insulation.

I have left out entirely some other insulations such as celluloid, as they are highly combustible, or do not belong here for other reasons.

The latest inventions in the insulation field, highly important for the electrical trade, are **Bakelite** and **Condensite.**

Bakelite is the invention of the well-known research chemist, Dr. L. H. Baekeland, who has been given world

recognition as the inventor of "Velox" paper. I do not need to say much regarding Bakelite, as Dr. Baekeland has given his invention wide publicity. He has lectured before the chemical societies of this country and others, and has read papers on his invention. Bakelite is certainly a great step forward for moulding purposes as a binder to be used in place of rubber substitutes. Using fillers such as proteids, wood-pulp, cotton, paper or asbestos, it moulds very well indeed, can be made heat-proof up to high temperature, and is very strong mechanically. Metal parts can be moulded into it. It comes under special licenses issued by the General Bakelite Company to the purchaser, and the manufacturer has to grind up the Bakelite, which is shipped in lump form, and make his own mixtures, or he can buy it from the General Bakelite Co., mixed up with fillers as ordered. These mixtures are pressed into shape in closed dies while using steam heat. The article is not quite finished when taken from these dies, but is then in so-called state "B." It gets the finishing process, state "C," in a vulcanizer, called by Dr. Baekeland, a Bakelizer.



Sternoid Moulded Insulation Part.

Condensite is the latest invention, and was invented by Mr. J. H. Aylsworth of Glen Ridge, N. J., who has spent most of his life in the laboratories of the Edison Company. Condensite is a high-grade plastic, which may be moulded up readily in its uncured state. The curing is done under heat and pressure. It can be moulded in closed or open dies. It presents a high finished black appearance like that of polished hard rubber, but is mechanically far stronger than rubber. It possesses high dielectric resistance, withstands most acids, with the exception nitric, sulphuric, and strong hydrofluoric acid, and climatic influences,does not break down by its own fatigue, is non-hygroscopic even if boiled in water, withstands heat up to 350 degrees Fahr. without softening, can be moulded into almost any shape. Metal parts can be moulded into it. It can be tapped, sawed or drilled easily, without taking the temper out of the steel. It is odorless and leaves the mould in a finished state. It has resiliency and its specific gravity is 20 per cent. less than that of hard rubber.

It is moulded by the Dickinson Manufacturing Co., using their own trade-name, "Stern-Condensite."

These are the most important insulations used at the present time for moulding purposes. They represent an immense improvement in the last ten years, and all firms are earnestly striving, with the purpose in view, to place still better electrical moulded insulations within the reach of everybody.

Manufacturers of electrical moulded insulations often have difficulty when submitting samples for test purposes to the purchaser to get just treatment. Every article made from moulded electrical insulation must stand certain conditions. When the manufacturer sends out his specifications and requests samples, he will get these samples in various shapes, thus preventing a uniform test. One of my friends connected with the Bureau of Standards in Washington is doing very good work by asking the manufacturers to make a few dies capable of making insulations of equal or uniform dimensions. If that can be adopted everywhere, samples submitted to the various buyers can be subjected to a uniform test. Such a test would be of merit, as it would clearly and quickly prove which insulation is best adapted for the purposes for which it is needed. I am glad to state that I am in full co-operation with such a move and believe all other manufacturers will be. A large Pennsylvania company has lately asked to build such a die. Some manufacturers will shortly submit samples of materials by using this die. Nobody has any advantage and an absolutely just conclusion can be reached, if all samples are subjected to an equal test.

I have taken about as much of your valuable time as I dared to today. There is much more to say, but I want to impress upon you most of all my earnest appeal to study electrical insulation, to try to place wherever you can, heat-proof, and, if possible, non-combustible insulation combined with dielectric and mechanical strength, to cooperate with the manufacturers of moulded electrical insulations and to try to make uniform tests.

For myself I wish to state with Browning—

> Let a man contend to the uppermost
> For his life's set prize
> Be it what it will.

My work satisfies me if I can only help.

Henry Van Dyke says—

> My Work—My Blessing.
> Let me but do my work from day to day,
> In field or forest, at the desk or loom,
> In roaring market-place or tranquil room,
> Let me but find it in my heart to say
> When vagrant wishes beckon me astray,
> "This is my work; my blessing, not my doom;
> Of all who live, I am the one by whom
> This work can best be done in the right way."
>
> Then shall I see it in not too great, nor small;
> To suit my spirit and to prove my powers;
> Then shall I cheerful greet the laboring hours,
> And cheerful turn, when the long shadows fall
> At eventide, to play and love and rest
> Because I know for me my work is best."

PENNSYLVANIA TRAIN LIGHTING INSTRUCTION CAR.

The Pennsylvania Railroad has recently placed in service a car lighting instruction car, similar in purpose to the air-brake instruction cars which have been in use for many years. The car is equipped with all types of axle lighting and head-end lighting in common use and will travel over the system, stopping at the various points where men in charge of electric car lighting are located. A very complete equipment of storage batteries is installed in the car and demonstrations of the right methods of caring for them will be given by experts. It is expected that the car will work a decided improvement in the operating force in charge of car lighting work. A complete description of this car well illustrated with photographs will appear in the December issue of the Railway Electrical Engineer.

The Light for Safety

By F. R. FORTUNE

Natural light has always been the criterion of that which is most desirable to obtain by artificial lighting. The broad problem in artificial lighting is how to obtain, with the comparatively feeble flux of light we have at our command from artificial sources, as close an approach as possible to the character of lighting obtained from the enormous flux of daylight. With the well-known limitations of artificial light it would, at first sight, appear impossible to reproduce in effect the conditions which obtain in daylight illumination. The development of the science of illuminating engineering has, however, demonstrated that step by step we are changing our methods of artificial lighting and approaching more nearly the ideal conditions. The handicap of artificial light is not nearly so great as would appear.

Contrast the problem of daylight with that of artificial lighting. We have, on one hand, a tremendous flux of light and an enormous area from which the light comes. Fortunately the eye is so constituted that we are capable of good vision between an extremely wide range of luminous intensities. We may see well, and without visual fatigue in daylight at an intensity of 500 foot-candles and more, and at 1 foot-candle and less. Under good conditions of artificial lighting we may see well and without visual fatigue at several hundred foot-candles intensity and at less than 1 foot-candle intensity.

The ability of the eye to adjust itself to very low-working intensities of illumination makes it possible to simulate daylight conditions in the design of the artificial lighting of interiors. While we recognize this possibility, we realize that before the completion of an ideal design, there remains to be performed a mass of experimental work, investigation and research, involving a close analysis of conditions of illumination of which we have practically no data at present, and, in general, a complete study of the problem from the physical, physiological and psychological standpoints.

Up to the present time, lighting by artificial sources has, for the most part, been carried on by illumination from substantially point sources. These are the sources with which we have to do for the most part at present.

In studying the principles underlying the application of artificial light to the illumination of interiors, it would be well to consider several subjects; first, flux of light; second, diffusion and direction of light; third, quality or color of light; and these studies may be defined in several items such as (1) character of the illuminant, (2) intensity of illumination, (3) system of illumination, etc.

We wish to dwell more particularly on quality of light, as that pertains more directly to our subject. Let us first look at the spectrum, running from red through to violet. Considering light as a physiological effect, it will be noted that some of the colors of the spectrum one can see by more readily than by others. This quality is known as luminosity. The relative luminosities of the colors of the spectrum are about as follows:

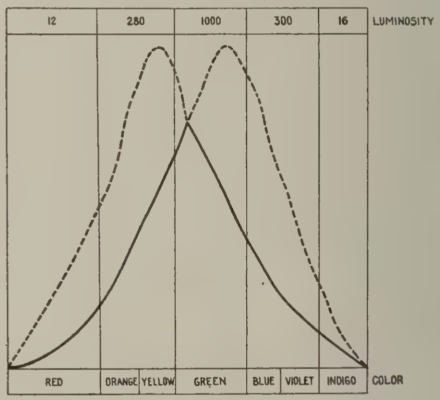
Ultra-red	0
Red	12
Yellow	280
Green	1000
Violet	16
Ultra-violet	0

Therefore, it will be readily seen that the colors in which the acuity of vision is greatest are yellow and green. Fig. 1 shows the physiological effect of the spectrum, and the average between the high and low intensities. This you will note shows a larger number of luminosities in the green than any other color.

Also, it will be readily seen by referring to the spectrum of the mercury vapor lamp that it has a very thin band of red and orange beyond the edge of the yellow, and then takes an abrupt rise in the yellow and green and gradually decreases into the violet while the other illuminants have almost a straight curve, across the entire spectrum.

There seem to be many differences of opinion at this time as to what monochromatic light really ought to be, but I am sure we are safe in accepting the theories of Dr. H. E. Ives and Dr. Louis Bell.

As Dr. Ives points out, the most efficient monochromatic radiation is almost in the position of the green mercury line which furnishes a very large percentage of the light of the mercury arc. For light of this wave length, Dr. Ives figures an efficiency of about 65 spherical candles per watt. The highest possible efficiency of white light in a continuous spectrum he reckons at 26 spherical candles per watt, so that the monochromatic



Variation of Luminosity with Color.

source has a prodigious theoretical advantage and practically a considerable additional gain, from the fact that the temperature required for Dr. Ives most efficient white light is about 6,000 degrees Centigrade, quite unattainable with any usable solid material.

Dr. Bell says in his article on "Chromatic Aberration and Visual Acuity": "In a strict technical sense, the light of the mercury vapor lamp, like that of the flaming arc lamp, is far from being monochromatic, but so far as effective luminosity goes the spectrum of the former is perhaps the closest approximation to monochromatism of the light of any commercial illuminant."

Dr. Bell points out also that "the quasi-monochromatic light of the mercury-tube lamp and other nearly monochramatic sources actually does give at ordinary reading distances, materially increased acuity for details in white on black or black on white. Such a monochromatic source shows, as judged by acuity measurements, roughly from one and one-half to two times its real photometric value when compared with light of continuous spectrum derived from ordinary incandescence. The experimental fact certainly is that the nearly monochromatic source

enables equal acuity to be attained at an illumination much lower than is necessary in the case of the light of the continuous spectrum in about the proportion stated."

Another peculiarity of the mercury light is that by taking two units, both of the same intensity, one for instance, yellow, as the flaming carbon arc and the other a bluish green light, such as the mercury lamp, and by going near the lamps, the yellow seems to increase more rapidly in intensity than the green and for a very short distance the flame appears glaring bright, while the latter disappears and shows nowhere near the same intensity. When going farther and farther away from the two lamps, the yellow light seems to fade out more rapidly than the bluish green and has practically disappeared while the bluish green is still markedly visible. The mercury lamp, therefore, can be seen from a distance at which a flaming arc is practically invisible.

It would therefore seem that the light of the mercury vapor lamp is more penetrating than a light of a continuous spectrum. This is particularly true in mills and shops where smoke and dirt arises from the floor.

Quoting from Dr. Steinmetz' work on "Radiation, Light and Illumination," "Hence, green and greenish yellow light are the most harmless, the least irritating to the eye, as they represent the least power. We feel this effect and express it by speaking of the green light as 'cold light' and of the red and orange light as 'hot' or 'warm.' The harmful effect of working very much under artificial illumination is due largely to this energy effect, incident to the large amount of orange, red and especially ultra-red in the radiation of the incandescent bodies used for illuminants, and thus does not exist with 'cold light,' as the light of the mercury lamp.

To summarize:

The mercury lamp has a maximum color in the yellow green, which we have shown has the greatest luminosity or seeing value. Also on account of the size of the light-giving area of the mercury lamp, shadows are eliminated more than with any other form of illumination. You realize that for special illumination it is necessary to have sufficient direct light to mark the edge of the objects by their shadows and thereby improve the distinction, but at the same time, there must be sufficient diffused light to see clearly into the shadows. A proper proportion of direct and diffused light is necessary. Sharp shadows, however, are dangerous.

One of the most dangerous things in working around a mill or shop at night is going in and out of a well-lighted building. One usually finds a momentary blindness after leaving a lighted mill or shop and going into the darkness. This is due to the contraction of the pupil generally caused by the eye being under a strain in a light of high intrinsic brilliancy.

In this connection, the following table which was prepared by Messrs. Ives and Luckiesh showing the candlepower per square inch of various light sources may be interesting:

Source.	Candle Power per Sq. In.
Carbon arc, crater	84,000
Flaming arc	5,000
Nernst glower	3,010
Tungsten-1.25 w. p. c.	1,060
Carbon-3.5 w. p. c.	400
Welsbach mantle	31
Mercury vapor	14.9
Kerosene flame	9

It is very interesting experiment to take two shops with comparatively the same intensity of illumination one lighted with mercury vapor lamps and the other with arcs or flaming arcs, and go from the mercury-vapor room out into the dark and notice how readily and easily you can almost instantly see; while going from the other shop lighted with arc or flaming arc it is necessary as soon as one steps into the darkness to stop and allow the eye to readjust itself for the new conditions. There is a blindness which seems to come over one. This is an important item which also should appeal to the "safety side" of mill illumination.

In closing, I wish to bring up very forcibly the subject of glare. At a recent meeting of the London Illuminating Engineering Society, the best definition for glare seemed to be "light out of place." I believe that glare and high intrinsic brilliancy go hand in hand and should be dealt with as a dangerous foe to safety. I do not think that I can impress too strongly upon the minds of you gentlemen the advisability of adopting a system of illumination that has a low intrinsic brilliancy and an absence, to the greatest possible degree, of glare.

Industrial Trucks for Railway Service

By T. V. BUCKWALTER

The motor truck has been developed in response to the insistent demand for very rapid and cheaper transportation within the enclosures of industrial plants, passenger and freight stations and on our public thoroughfares. The amount of trucking has been greatly increased by a reduction in the cost of transportation due to the development of the steam locomotive which performs the longer end of the haul, the collecting and distributing being handled by trucks while the transfer between the trucks and cars is accomplished by manual labor. The industrial truck has been developed chiefly to replace manual labor in that portion of the general problem of transportation represented at the origin and final delivery of material.

Motor trucks in railroad use may be divided into three general classes:

First—Trucks used to replace box cars in the transportation of freight between adjacent freight stations.

Second—Trucks operated in competition with horse-drawn vehicles in the transportation of passengers and freight on our general highways.

Third—Trucks utilized to replace and supplement manual labor and which are covered under the general term, industrial trucks.

Trucks to Replace Box Cars.

It is a difficult matter in some cities covering wide territory to secure uniformly high average loads in less than carload business. With the object of increasing the average load it is the practice to utilize so-called ferry cars in the transportation of freight between stations in the same city. The use of motor trucks in this service results in a reduction of 24 hours in some cases and the cost of operating the motor truck is more than offset

by the release of the railroad equipment. The quicker transfer results also in a greater utilization of platform and track space in stations.

Trucks to Replace Horses.

Motor vehicles of this class are utilized in taxicab service, internal transportation at shops and in store-door delivery.

Taxicabs.

Taxicabs have been more generally introduced at the larger stations and are generally operated by outside companies on a commission from the railroad company, the latter receiving a portion of the total business without incurring any risks. Taxicabs propelled by gasoline motors appear to be preferred by the general public, as the operation is less affected by adverse weather conditions and the greater power available with limited weight permits of operation at greatly increased speeds over other forms of motor vehicles, which is an important consideration, as the saving in time is the chief justification for their use.

Shop Trucks.

Shop trucks are used in the larger railroad shops in the transportation of materials over the public highways. They are used to replace horses and railroad equipment, and have a distinct advantage over the latter in that material needed for immediate consumption may be delivered without delay. There is no material economy in the operation of motor trucks over horse-drawn vehicles where the greater part of the driver's time is taken up in the transfer of material to and from his truck, but advantage results if saving in time is an important consideration. The motor truck is most efficient when operated at full load for long distance over good streets, in which event the labor of loading enters less as a factor in the total cost of operation, and higher speed permits of a greater number of trips being made.

Store-Door Delivery.

An important field for the operation of motor trucks is in the collection and delivery of freight by an agent of the railroad company, this service being generally referred to as store-door delivery. A saving in time and total cost of transportation from point of origin to consignee's sidewalk is effected while the railroad is benefited to the extent that freight stations are relieved of congestion both in warehouse and receiving space.

Delivery can be effected more economically by a large company doing all the draying from railroad stations than by a large number of individual merchants, for the reason that the latter as a rule receives a small consignment, while the large transfer company may load its vehicles to their capacity in both directions. The work could advantageously be placed with a concessionaire for the reason that work of this character does not appear to be economically managed by the more cumbersome organizations of the railroad companies. The railroad company may be benefited indirectly by the fact that the concession to operate store-door delivery gives the operating company considerable advantage over competitors, and should lead to its securing the bulk of the business of the community, with a consequent lower cost of railroad delivery service.

The general use of motor trucks in connection with store-door delivery is possibly the best solution of the congested condition of the New York City street system, and would afford an increase in freight capacity of the streets as the taxicabs have increased the passenger capacity.

The use of electric trucks presents some advantages over gasoline, in that operation by a cheaper class of labor is possible, but the heavy weight and small power limits the mileage on one charge, while the gasoline truck can be provided with ample power and fuel capacity for one-hundred or one-hundred and fifty miles, and the power of the truck does not diminish as the day progresses, as the case with electric trucks.

Industrial Trucks.

The term industrial trucks is used to designate the machines that replace manual labor in the internal transportation within industrial establishments, freight houses and passenger stations. A distinct form has been developed to fulfill the peculiar conditions met with in each of these lines, classified as follows:

Electric Shop Trucks.
Electric Baggage and Mail Trucks.
Electric Warehouse Trucks.

These are all for internal transportation, and therefore electricity is the only form of motive power available on account of fire risk and odors, and because of the readiness with which this motive power lends itself to simplicity of control.

Electric Baggage and Mail Trucks.

The transportation of mail and baggage at main line stations has increased to such an extent that it seriously interferes with the expeditious movement of traffic, and requires the services of a large and continually increasing force of men. Until recently hand-operated trucks have been used exclusively in this service, the work is rather severe, but does not require a high order of intelligence, and consequently a poor class of men have been employed. Pulling a heavy truck is very exhausting, and the porter arrives at the Baggage Room in poor condition to quickly unload mail or baggage, and the practice of rushing mail and baggage, delayed in delivery from the Baggage Room to the trains becomes more dangerous as the passenger traffic increases, as hand trucks are not provided with brakes.

The Pennsylvania Railroad early reconized the desirability of motor-operated baggage trucks for the relief of the baggage service, and about eight years ago purchased two standard electric commercial trucks, and placed them in service at Jersey City Station. These trucks had a capacity of 4,000 lbs. and were very heavy, the weight being approximately 8,000 lbs. The driver's seat extended the whole width of the machine, and steering was accomplished by wheel, from one end of the truck only. The body was housed in by wire netting, with sliding doors on each side for access to the interior. It was impractical to turn single end of trucks on the platforms, and was therefore necessary to run to the end of the train shed and turn to an adjacent platform to turn around. Therefore a material economy in time and labor was not effected.

Further experiments were then made by applying motor, batteries, and steering gear and controller to standard size hand trucks, and about six years ago three trucks of this general character were constructed and one purchased from a company. These were all operated on the single and principle, and no provision was made for the operator to ride. The only work accomplished by motive power was that of pulling the truck. No material increase could be made in the speed, for the reason that the drivers would not move faster than an ordinary walk. When the trucks were speeded up, the driver simply regulated the speed by throwing the controller on and off at frequent intervals.

The steering was not as safe and positive as was desirable, for the reason that a man in walking is not standing squarely on either foot and therefore is not in position to resist side thrusts due to one or the other of the steering wheels striking on obstruction.

The brake was likewise lacking in effectiveness, as it was either operated by the controller handle direct or indirectly by solenoid magnets. The direct brake was not effective without considerable exertion on the part

of the driver, while the solenoid brake could only be made effective by consuming current approximating 10 per cent of that necessary to drive the truck.

All of these trucks were operated on the single end control principle, and it was therefore difficult and sometimes impracticable to turn on the narrow platforms generally found in passenger stations. The speed at which these trucks operated varied from 2½ to 3½ miles per hour.

Mail Truck Double End Control.

A thorough study of the operation of the experimental trucks led to the conclusion that a radical departure in automobile design would be necessary to produce a successful electric baggage truck. The most important thing made apparent by their operation was, that the electric baggage trucks should be operated with equal facility from either end. In other words, should have double end control. This would avoid the necessity of turning on narrow platforms or runways where other traffic would be interfered with, which always leads to more or less congestion as the turning of a truck places it for the time being at right angles to the general trend of traffic.

It was also apparent that provision should be made for the driver to ride at either end, for the purpose of running at a higher speed, and for the conservation of his energy for other work, and to give him better control of the truck.

The class of labor met with in this service required that the manipulation of the controlling levers for the controller, steering gear, and brake should be in the manner most natural to the ordinary baggage porter, and that all controlling mechanism should be operated directly. While at the same time the steering gear should be operated with little effort, so as to be absolutely under the control of the driver.

The greatest possible amount of stability is required, and therefore the trucks should be constructed with four stable points of support, while the truck frame should be flexible that each wheel carry its portion of the weight.

It was also found desirable that hubs and all apparatus should not project beyond the side sill of the truck, as to reduce danger of collision with columns, other trucks and railroad equipment, and that the controlling apparatus should not project beyond the end of the truck when not in use.

The incorporation of these desirable features on one truck led to the design of an experimental double end truck, in which the general dimensions of the hand trucks were adhered to, for purposes of trial at any of the stations on the system, and with the idea of gaining experience, the design involved the use of hand forgings instead of the more expensive, but lighter and stronger pressed steel work and drop forgings.

Twelve trucks were therefore constructed and placed in service at the new Washington Terminal, then nearing completion, and the success of the trucks at that point led to the design of larger machines, embodying the use of power saving devices, and the general adoption of pressed steel and drop forged construction.

Straight Frame Truck.

The first truck produced after what might be called the experimental stage was the straight frame truck, having a continuous frame with platform 30 inches in height, 12 feet in length and 44 inches in width. Twelve of these trucks were placed in regular service at Jersey City Station, July, 1909. The operation and performance was closely studied by the Motive Power and Operating Departments.

A marked improvement in the operation of baggage and mail departments resulted from their operation, and for the first time in the history of the station, the baggage was handled as a regular thing from a ferry boat to the train before the passengers. The baggage departments were enabled to handle rush business in vacation periods without taking any extra men on, resulting in a considerable improvement in the baggage service generally. It had been the practice to take on green men from the freight department, with the consequent confusion at times in the proper dispatching of baggage.

The performance of these trucks in general was so satisfactory that the same general design of mechanism was adopted for electric baggage truck having drop frame, for service in the new Pennsylvania Station, New York, and as the drop frame trucks represent the highest development in the design and construction of industrial trucks, a general description of the detail feature entering into the construction will be given:

Drop Frame Truck, Double End Control.

The truck is the same length and width, namely, 12 feet and 44 inches, respectively, as the straight frame truck, but the frame is dropped for a distance of about 7½ feet between the wheels. The height from the drop portion of the floor being only 9 inches. The object of this construction is to facilitate the transfer of baggage and mail between the truck and the car at the depressed track construction used at the Pennsylvania Station, the height of the baggage truck floor being practically the same as the car floor.

As in previous design the truck is operated with equal facility from either end, and as a general rule the driver does not know or care whether he is operating from the motor or battery end, as the steering, controlling and braking apparatus is identically the same in either case. The frame and floor of the truck is 30 inches high for a length of 2½ feet at each end, and this portion of the frame is arranged to form an integral guard and protection for the motor apparatus and wheels.

The motor, counter shaft housing, controller, and automatic switch are mounted in the housing at the motor end, and the driving is done on the two wheels under this housing. The battery and brake apparatus is mounted on the other end of the truck, termed the battery end, and the braking is accomplished on these wheels, it being a desirable feature to have the braking done on the heavier end of the truck, to provide for skidding the driving wheels if necessary.

The driver rides on either of two small pressed steel wood lined platforms, hinged at the extreme ends of the truck. These are connected together and only one can be bought to the operating position at one time, and the opening of either platform involves the closing of the other. The object of this construction is to provide the maximum load carrying space consonant with safe operation on the elevators, and to obviate all projecting apparatus beyond the end sill opposite from the driver, for the purpose of reducing the element of danger in backing on elevators.

The frame is of pressed steel throughout, of a substantial design that gives an ample strength for a load three times the rated capacity. The center sills are composed of 3-inch standard "Z" bars, for the reason that this section permits of more ready attachment for the driving and controlling apparatus, having in mind that all steering, braking and controlling connections must be carried from end to end of the truck. The motor housing and end standards are of channel sections, pressed, with integral gussets for attachment to center and side sills, and this method of construction permits of the greatest strength with the least weight, an important consideration in electric trucks. The upper and

lower side sills have a special section, providing a round edge 1 inch wide and projecting one-fourth of an inch above the floor line. The object of this construction is as follows:

First: To retain lading from sliding off.

Second. To provide round surface to take wear of unloading and loading.

Third. To provide for removing floor boards independently.

Fourth. To provide full depth of beam without occupying space for floor, for instance the height of the section of the lower side sill is 4⅜ inches, while the clearance between the lower flange of the sill and the floor is 5 inches, while the height of the floor is only 9 inches.

The wisdom of this strong frame construction is shown by the fact that the trucks have repeatedly fallen from the platform to the road bed, 4 feet below, and have fallen into elevator pits a distance of 10 feet without injury to the frame.

The motor is a series wound, 4-pole, 24-volt machine, especially designed to give characteristics suitable for this service. The motor is spring supported on the frame and flexibly suspended on the countershaft housing, to permit a certain degree of oscillation to take up shock in starting. The armature is mounted on annular ball bearings. The normal current consumption and point of highest efficiency is 40 amperes, although four times this current can be successfully commutated.

Electric Baggage Truck Pulling Three Trailers.

The low voltage of 24 volts is used for the reason that the motor is of much more rugged design than the higher standard voltage of 85. While the controller provides a series of steps for starting, the class of drivers generally met with in industrial service generally use the controller as a knife switch, with the result that the motor is required to withstand the shock of the full battery voltage across the armature leads. The 24-volt motor, which is of a more rugged design, is better adapted to withstand the shock than the higher standard voltage machine. The fact that there has been practically no motor trouble in six years' experience verifies this statement.

The motor is connected through spur gearing with double reduction to the driving wheels having a ratio of approximately of 25 to 1, which gives an immense driving power for starting. The motor pinion engages with the countershaft gear, which is supported by a differential gear mounted on ball bearings mounted in the countershaft housing. Both sides of the differential are connected through independent countershafts to universal pinions which mesh with internal gears cut directly into the rim of the driving wheel.

The universal pinions are the unique feature about which the design of the truck hinges. They consist of universal joints, incorporated within the center of the driving pinion, and these universal joints are placed in vertical alignment with the steering knuckle, so that the driving pinion is free to follow the motion of the driving wheels in steering. A simpler method of driving steering wheels is difficult to produce, and this feature of driving the steering wheels permits of using four-wheel steer, which is undoubtedly one of the principle features making for the success of these trucks in the peculiar service in which they are operated. The differential, mounted on ball bearings, together with the driving gear, operates in oil.

The controller is operated by the left hand of the driver from either end of the truck, and provides three speeds in either direction. The controller handle may be inserted or removed only when the controller is in the neutral position. The controller is built up in a flame-proof metal case, as are likewise all electrical connections which are broken in the regular service of the truck which would be likely to generate a spark.

The controller is raised upward for forward running, and pushed downward for backward running, which is the method that comes most natural to the drivers met with in this service.

An automatic switch opens the main circuit when the driver steps off either platform by means of interconnection between the platform and the switch, and the automatic switch is also opened when the brake is applied, thus making it impossible for the driver to regulate the speed by applying the brake. Both the controller and the switch are operated by means of bell cranks and levers, as the connections of this character are less likely to develop back lash after long service than are geared controllers.

The brakes are mounted on the steering wheels at the battery end, and consist of internal expanding shoes bearing directly against the rim of the wheel. The brakes are operated by pedal from either end of the truck. The brake pedal being brought to the operative position when the driver's platform is lowered. A special plastic bronze has been developed for use on these brakes which produce a velvety action, with but little wear. A series of tests shows that this material wears less in braking service than any of the common materials in general use.

The brake is applied directly by pressing the brake pedal with the foot, the most natural method for the ordinary driver. The brake is also applied automatically but without complicated mechanism when the driver leaves or steps off the platform.

Battery. The truck is designed to accommodate either the lead or Edison battery, delivering 24 volts. The lead battery consists of 12 cells with 15 standard pasted plates. The battery is assembled in a single tray, which is removable as a unit, and by transferring batteries, which requires but a few minutes time, the trucks may be kept in operation 24 hours a day. The batteries on the 35 trucks at Pennsylvania Station are never charged on the trucks, but are always changed, and these trucks are in service 24 hours a day. The weight of the lead battery is 600 lbs. The Edison battery equipment consists of 20 or 21 cells with a weight of about 300 lbs.

The lead battery composed of 12 cells is superior to one composed of a greater number of cells, in that the weight as compared with a 24-cell battery is reduced 5 per cent, and the cost about 18 per cent, while the chance

of breakage of jars, plates, and connectors, etc., is reduced one-half with corresponding probability of continuous service, by the use of the fewer number of cells. Batteries are spring supported, and the life of 26 months has been attained in this service. The batteries are removed from the trucks by a special design of transfer hook.

Steering is accomplished on all four wheels to obtain minimum turning radius and to provide for operation in narrow and restricted runways, for the reason that the front and rear wheels track with each other on four-wheel steer trucks, with the result that the driver need only watch the end of the truck on which he is riding, while the knowledge that the rear of the truck tracks with the front lends a confidence not otherwise attained.

A truck can be operated in any of the runways met with in baggage service, which in some cases are not more than 6 inches wider than the truck frame.

The steering lever is mounted in a vertical steering post, one being provided at each end of the truck and connected with the four wheels. The position of the

Electric Shop Truck.

steering handle is an indication of the direction of travel, the handle is pushed to the right to run to the right, and pushed to the left for operation in that direction, this being a method that comes most natural to the class of drivers met with in this service. The steering knuckles, steering arms, steering post and links are drop forged from axle steel, but wearing parts are hardened and ground and mounted in hardened ground bushings and thrust washers. The most important result of the four-wheel steering arrangement is that shocks as effects the driver are greatly minimized. For instance, with two wheels steering, a shock to one wheel is transmitted to the other and partly absorbed, but the bulk of the shock is borne directly by the driver through the steering gear, but in four-wheel steer machines with substantial drop forged construction, the shock to one wheel is transmitted directly to the other three wheels, where it is absorbed by inertia before being transmitted to the steering lever. The shock is therefore reduced to one-third of the two-wheel steer truck.

The steering knuckles shown in the attached cut are of special construction for the purpose of reducing hub projection. This is a very desirable feature in industrial truck operation, as the possibility of collision with either trucks and columns, and railroad equipment is entirely obviated. The projection of the steering knuckle is entirely within the rim of the wheel and the side sill of the truck, and this result is accomplished by inverting the inner Timkin Roller Bearing. The outer race is carried in the steering knuckle, and the inner race is mounted on the inwardly projecting hub of the wheel.

The wheels are of the artillery type, of a special construction. The spokes are made of rectangular cross section throughout the entire length, and have a bearing directly on the barrel of the hub and on the rim of the wheel, and are clamped between integral and separate flanges at the hubs, and between an integral and separate flanges at the rim, with the result that the effect of the end grain of the spokes cutting into the cross grain of the felloe is entirely obviated in this construction, and after several years operation the wheels are apparently as sound and intact as when constructed, quite the reverse of the ordinary automobile truck wheel. The driving gears are incorporated as a part of the driving wheels, while the brake band is likewise a part of the wheels on the battery end of the truck, thus avoiding transmission of driving or braking strain through the spokes and hubs, and this construction no doubt conduces to the long life and freedom from repairs to the wheels.

The tires are of a special section, designed to provide a certain amount of resilience, but the chief consideration is a reduction in rolling resistance. The width is 3½ inches, and the diameter 27¼ inches. The tire equipment is conservatively rated, as after 26 months' operation, the tires show but little more than the crown of the tread worn away, and, from present indications, pointing to a life of four or five years.

Every effort is made to conserve the energy of the motor and battery, annular ball bearings of the highest grade are used in the motor and countershaft throughout, while Timkin Roller bearings are utilized in the wheel, with the result that one man can easily push a truck with a load of 8,000 pounds, and the current consumption is reduced to a minimum.

The axles are of "I" section, with a depth of 3 inches and 2 inches in width, but the strength of the truck is greatly increased by combining the axle with integral brackets which provide a journal for the countershaft housing and support for the upper center sills. In the drop frame truck the axles are attached directly to the upper and lower center sills. The axles are cast from material developed for use in construction of malleable couplers. The strength of the axles and frame and stability of the truck is greatly increased by bolting the axles directly to the sills, avoiding the use of springs entirely, which experience has shown are entirely unnecessary in this service, as the narrow width of the truck, namely, 44 inches, together with the height of the lading 9 to 10 feet results in the lading being thrown if attempt is made to use springs.

The rubber tires which are necessary to prevent skidding and to obtain traction, provide sufficient cushion for the speed at which it is advisable to operate baggage trucks.

Speeds: The controller is proportioned so as to provide, first, a starting speed of about two miles an hour; second, a running speed of about 4 miles an hour; third, a running speed of from 6 to 7 miles an hour, available in either direction. This speed is from two to three times that of a hand truck, and it has been found de-

sirable to make an increase over these, for the reason that they would not be available for operation on narrow runways generally met with in baggage departments. Higher speeds could easily be obtained if runways were of sufficient width to permit of safe operation.

The capacity of the truck is rated at 4,000 pounds, although loads from 6,000 to 8,000 pounds are handled daily, and 14,000 have actually been handled safely on the truck. The drop frame truck provides a space of practically 11½ feet long, 4 feet wide and 9 feet deep for lading, and this easily accommodates 4,000 pounds of baggage, but second-class mail loaded to a depth of 7 feet from the ground, the height of the end standards of the truck provides a load of from 6,000 to 7,000 pounds, which taxes the elevators to their capacity.

Weight: Every effort was made in the design to keep the weight down to a minimum, as the cost of carrying dead weight is a considerable factor in electrically operated trucks. The weight of the drop frame truck, a difficult design, is about 2,700 pounds, which is about two-thirds the capacity of the truck, and less than half the weight of the ordinary commercial truck of this rating.

Drop Frame Trailer Truck.

A large amount of baggage and second-class mail is delivered to the baggage department sometimes several hours before leaving time of the train, and with the object of relieving congestion in the baggage room it is the practice to load this material on storage trucks, which would be placed at any convenient place, generally on the baggage concourse or the platform from which the train is scheduled to leave. Before the introduction of motor trucks the storage material was handled entirely by manual labor, and it was not objectionable to use hand trucks for storage purposes for a considerable period. It was not desirable, however, to use a rather expensive piece of apparatus as a motor truck for storage purposes, and this led to the design of a truck to handle this storage material and which would be adapted for operation as trailers behind the motor trucks.

The trailer trucks were made practically identically as regards frame construction with a drop frame motor truck, the overall dimensions and carrying capacity being identical. The motor equipment, battery, driving and braking apparatus was omitted, but the steering arrangement is practically identical with that on the motor truck, with the exception that instead of mounting the twin sockets on the steering post, a steering lever pivot was used in lieu thereof. A combined steering coupling rod adapted for engagement in the steering lever pivot was used as a handle for operation by hand, and as a coupling and steering rod when engaged with a special coupling hook mounted on either end of each motor truck. A coupling hook of this character was also mounted on each end of each trailer truck, and four or five trailers may be hauled behind one motor truck.

The steering gear was laid out in such a manner that the motor truck would advance its own length on a curve before operating the steering gear on the next following truck, and in like manner the complete train of trailers would run around curves and in narrow runways without deviating more than a foot or so from the path taken by the leading truck. Operating conditions, however, do not permit of loading trains of four or five trucks destined to the same point, and as a rule the baggage trains do not consist of more than one motor truck and one or two trailers.

The wheels are of practically the same construction as those used on the motor truck, but special wood tires with the wear coming edgewise on the grain were used. The rolling resistance is very low and wearing properties are excellent, but the shock absorbing properties are poor, the trailer trucks being somewhat more noisy than the motor trucks. It is possible that rubber tires will be used on any trailer trucks built in the future.

A cut showing a train of one motor and three trailer trucks loaded is shown herewith.

Straight Frame Truck.

The straight frame trucks as the name implies has a continuous frame of 30 inches in height and from 9 to 12 feet in length, the standard size being 12 feet. The frame is somewhat simpler in detail construction than that on the drop frame truck, and the weight is about 300 pounds less, or about 2,400. The height of 30 inches to the floor is about midway between the platform and the car floor on the ordinary passenger station, and provides great carrying capacity with ease of transfer of load to the truck and from the truck to the car. It is considered, however, by some of the operating people that the drop frame truck is preferable under all operating conditions, on account of its ease of loading in the baggage room and the greater carrying capacity.

The motor, controller, driving arrangement, wheels, tires, bearings are practically identical with those used on the drop frame truck. The battery is of the same capacity and the cells are interchangeable with those on the drop frame truck, but the suspension is considerably different, as the straight frame truck provides space for use of an under slung battery mounted on three point

Electric Truck Used in Handling Storage Batteries.

coil spring suspensions. The battery is instantly removable permitting of the operation of the trucks for 24 hours a day where necessary.

Electric Shop Truck.

A very large amount of internal transportation is conducted within the enclosures of large railroad shops and industrial establishments. It is the general practice to handle this work with small four-wheel hand operated trucks, pulled by from one to four men, while quite frequently eighteen men furnish the necessary motive power for hauling locomotive frames on small hand trucks.

Motor trucks have been introduced in some of the larger shops to assist in the internal transportation of materials in course of manufacture. Runways and trucking aisles are as a rule restricted in shop enclosures more than in trainsheds, and this, together with the heavier materials transported, has led to the adoption of a smaller truck for this service, which, however, re-

sembles the straight frame truck in general appearance. The double end control is a particularly valuable feature in connection with this service.

The operation of these trucks is conducted on a regular schedule between the various storehouses and departments of the works. An increase of the general efficiency of the plant results because of the necessity of the foreman having the material ready for transportation on schedule time, while the overload capacity of the motor truck avoids entirely the old practice of temporarily supplementing the laboring gang by machine operators. The shop trucks have actually replaced five or six men each, and as the total operating cost, including interest on investment, depreciation on trucks, tires, batteries, current and repairs is less than $300 a year, the truck pays for itself once every four or five months.

Electric Trucks for Coach Yard Service.

The large size and consequent long distances for transportation of supplies and repair material at the Sunnyside Yard, operated in connection with the New York improvements led to the design of a special electric truck for service in the transportation of storage batteries, dining car supplies, Pullman car supplies and general yard service at this point.

The runways between tracks are less than four feet wide, and this limits the maximum width. The necessity of transporting train lighting batteries, which weigh 350 pounds per unit, in connection with the narrow space available compelled the use of single end truck, while to obtain the shortest possible turning radius, the four-wheel steer was decided upon.

The size of the truck was controlled by the conditions governing transportation of train lighting batteries. The length of the body is 8 feet, sufficient to carry eight two-cell trays and permit of transferring additional units from the car. The width is 36 inches at the motor end, tapering to 30 inches at the rear, while the height is 18 inches to permit of readily transferring lighting batteries from the battery compartment on railroad equipment. The battery, motor, controller, driving, braking and steering apparatus are all mounted and housed in a motor compartment at the front end of the truck, to which is also secured a standard driver's platform, as used on the baggage trucks. The motor, controller, driving mechanism, bearings and axles are of the same general type as used on the other truck, although the driving mechanism and axles are somewhat smaller on account of the more restricted space limitation. The brake is mounted in the countershaft housing, and is operated by a foot pedal and by automatic application, in the same manner as developed on the baggage trucks. The capacity of the truck is 4,000 pounds, while the weight is about 1,600 pounds. The speed is practically the same as the baggage trucks, namely, two, four and six miles an hour.

Cost of Operation.

The experience thus far derived from the operation of industrial trucks would indicate the cost of operation to be as follows:

Interest at 6 per cent on investment $1,250	$ 75.00
Depreciation less tires and battery $1,000 at 8 per cent	80.00
Chassis and tires $100 at 100 per cent	100.00
Depreciation of battery $150 at 50 per cent	75.00
Maintenance, repairs	100.00
Current	40.00
Total cost of operation per year	$475.00

From present indications the operation of each warehouse truck of this type results in the saving of two men, which at $60 per month or $720 per year results in saving per truck $970 per year.

The truck is capable of transporting about 90 tons per day, or 27,000 tons per year of 300 days, equal to a cost per ton excluding labor of 1.74 cents.

The shop truck has actually replaced six men, equaling a saving in labor of $3,600 per year. The cost of operation being $400, which represents a saving of $3,200 from the operation of the truck per year without placing a monetary value on the increased shop efficiency, due to the transportation of material on schedule time.

Operation of Baggage Trucks.

Electric baggage trucks with double end control have now been in service at some points for upwards to 4 years, and railroad officials who have had the operation of the trucks under their control are unanimous in their expressions as to the value of this system of handling baggage and mail, and their use represents a distinct step in advance.

Among the chief improvements in the service resulting from the operation of the electric trucks might be mentioned; reduction in time required for the transportation between the baggage room and the train, with a quicker delivery of baggage to patrons and a shorter allowance of time for delivery of late baggage to the trains.

At some of the through division points, electric truck operation has resulted in the reduction of layovers in connecting trains, due to the more prompt handling of baggage and mail.

CAR LIGHTING MANAGEMENT IN ENGLAND.

The Great Western Railway of England maintains a lecture and debating society which meets regularly to discuss points in regard to railway operation. At a recent meeting of this society a paper was read on "Electric Lighting of Trains," from which the following information has been abstracted.

A special staff of 15 men is distributed throughout the system to supervise electric lighting matters, and reports are despatched daily to the head office as to the repairs carried out on the electrical equipment. An interesting system is adopted in connection with the storage batteries. For this purpose an indicator board is used, divided into three sections, each representing a year. Each of these divisions is further subdivided into months, and a row of pins is affixed opposite the name of each month. Every coach in use carrying a set of batteries is represented on the board by a tab bearing its number, one side of the tab being painted red and the other green. When the battery is first put in use the green side is placed outwards, the tab being affixed in the row corresponding with the month when it was put in service. The batteries on each coach are thoroughly overhauled every 11 months, and by this time the tab has been altered in position, so that it is 12 divisions away from its original place, each division representing a month. The red side of the tab is then turned outwards, and the inspector is notified that the batteries of that particular coach require immediate overhauling.

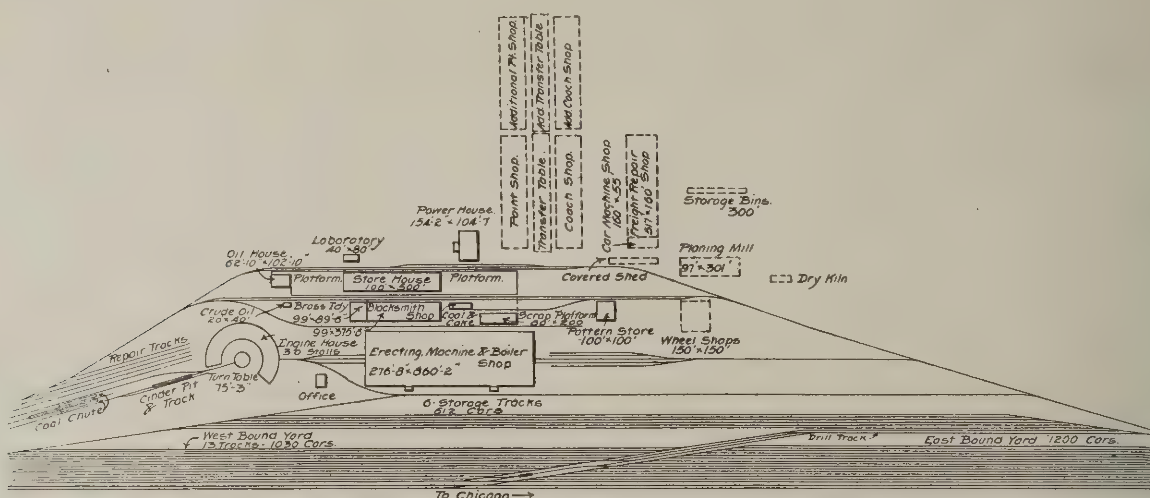
SHOP SECTION

EDITED BY GEO. W. CRAVENS

Shop Series 7—Rock Island System

The principal shops of the Rock Island System are located at Sylvis, Ill., on the flats along the easterly bank of the Mississippi River. These shops occupy the south half of a tract about one-half mile square, the north half being reserved for extensions. The main line and car storage tracks lie along the south edge of the grounds, there being 9 miles total of track in the yards. Two tracks extend through the erecting shop, one through the blacksmith shop, two each side of the main storehouse and one serves the power house for coal, etc.

At present there are no buildings for making or repairing cars here, locomotive work being the only kind provided for. The buildings now include a locomotive machine, boiler and erecting shop 276 ft. wide by 860 ft. long, a blacksmith shop 99 ft. by 375 ft. with a brass foundry 99 ft. by 89 ft. at one end, a store house 100 ft. by 500 ft. three stories high, a round house with 30 stalls and numerous smaller buildings. Among these are the two-story office building, the main power house 154 ft. by 104 ft., a laboratory, 40 ft. by 80 ft., oil house 63 ft. by 103 ft., and pattern storage 100 ft. by 100 ft.



General Layout of Rock Island Shops at Silvis, Ill.

Provisions for car shops to be erected later include two paint shops each about 130 ft. by 575 ft., two coach shops of the same size, a freight repair shop 160 ft. by 575 ft. with a 55 ft. machine shop in one end, a planing mill 97 ft. by 301 ft. and a wheel shop 150 ft. by 150 ft.

The general arrangement of these shops is shown on the accompanying plan, the layout being planned to allow turning out the work with the least handling of material. Several unusual features have been incorporated here which will be described later.

Power Plant.

The power plant lies to the north of the present group of buildings in what will eventually be the load center of the shops, future extensions being planned with this in view. The building is divided lengthwise by a brick wall, making the engine and boiler rooms each 50 ft. wide by 154 ft. long. All piping and wiring and most of the auxiliary apparatus is in the basement, and an overhead crane is provided in the engine room.

Instead of the usual large stack, induced draft is provided by fans located in a 27-ft. by 42-ft. annex. There are two of these fans, each 12 ft. diameter by 6 ft. wide driven by two 12-in. by 12-in. horizontal steam engines. Each fan is capable of exhausting the gases from all of the boilers, and a small stack is provided for carrying off the gases. Coal is delivered directly from hopper cars to a hopper over a coal crusher and thence by a conveyor to overhead storage bins. A coal storage bin of 32 tons capacity is provided for each boiler. The conveyor has a capacity of 50 tons of coal per hour, and is also arranged to carry ashes from the pits to a hopper over the track outside building.

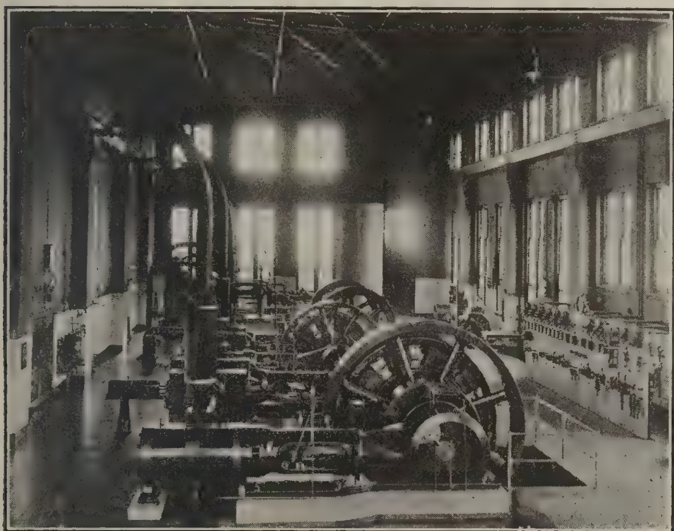
The engine room contains one 250 k. w. Ft. Wayne generator driven by a 350 h. p. Buckeye non-condensing cross-compound engine and one 500 k. w. Ft. Wayne generator driven by a 700 h. p. Buckeye non-cond. cross-comp. engine, space being provided for another 500 k. w. generator and engine. The engine room also contains two Class "G" Ingersoll-Sargent air compressors of 1500 cu. ft. capacity each, two Worthington duplex pumps, two Bullock balancer sets, one T. C. 4500-750-250 rotary converter and a 14-panel white marble switchboard.

Power is generated at 250 volts, continuous current, and leaves the power house through underground conduits to the principal buildings. Beyond these the lines run overhead. Power to cranes, heating fans and constant speed machine tool motors is distributed at 230 volts by two-wire system, whereas a 230/115 volt 3-wire system is used for feeding variable speed motors and for lighting. These latter voltages are at the machines, not at the generators.

The total connected load is 1,805 k. w., and the average load 648 k. w. Of this, the lighting load is 148 k. w. and power load 500 k. w. The maximum recorded load up to date is 888 k. w.

There are seven Babcock and Wilcox water tube boilers of 300 h. p. each in the boiler room, all

equipped with Green traveling grates and stokers. Steam is carried to a main header back of the boilers, and on the boiler room side of the partition wall, and thence to engines. The auxiliaries include a Webster feed-water heater, a Green fuel economizer, a Deane triplex pump and two Worthington pumps. In the basement of the power-house is a repair shop in which all repairs to electrical machinery are made. Armatures for car lighting equipment are here rewound and put in shape.



Interior of Power House.

Locomotive Shop.

This is the principal building at these shops and is divided into five aisles or sections running the full 860 ft. length of the building. It is very well lighted through a large skylight along the center, four rows of lantern windows in the sides of the roof sections and the large windows in the walls. For artificial light there is an arc lamp on each alternate column of the center aisle and one in each alternate space between columns along the side aisles. There is also a row of arc lights along the center of the main aisle, above the crane way.

Electric Crane with Lifting Magnet.

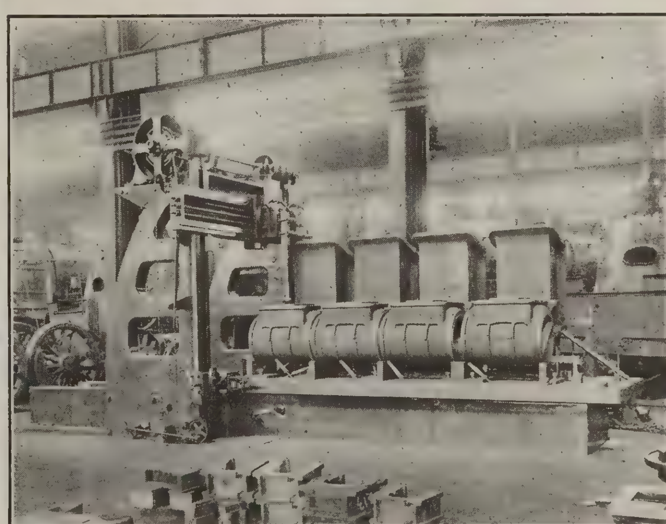
A peculiarity of this shop is the placing of the repair pits at a sharp angle with relation to the building instead of at right angles. There are 38 of these pits, each 36 ft. long, and two stripping and three finishing pits each 132 ft. long, all in the center aisle of the building.

The two aisles north of the main aisle contain the tank and tender shop and the boiler shop, the latter filling the easterly third of the space. The small machine tools are located near the north wall in the outer aisle and are mostly group driven, while the larger machines stand in the second aisle and are driven by individual motors. The hydraulic machinery in the boiler shop is also located in the second aisle.

The machine tools for locomotive work are located in the two south aisles; these also are arranged so the smaller ones are near the outside wall and driven in groups, while the larger ones, such as wheel lathes, planers, etc., are in the aisle next to the main one, and are driven by individual motors. Two tool rooms, four fan rooms, four toilet and locker rooms and a foreman's office are provided in this building. There are nine cranes here, as follows:

Two 50-ton traveling bridge cranes.
One 20-ton traveling bridge crane.
One 10-ton traveling bridge crane.
One 5-ton traveling bridge crane.
Two 3½-ton traveling bridge cranes.
Two 1-ton traveling wall cranes.

Locomotive Erecting Shop.



Large Planer with Individual Motor Drive.

Blacksmith Shop and Foundry.

The building containing the smith shop and brass foundry lies next north of the locomotive shop. This is also well lighted through the lantern roof and a double row of windows in each wall, with a large number of arc and incandescent lamps for artificial lighting. The num-

ber of machine tools here is naturally small, there being only about 25 of them, two-thirds of which are group driven. This shop contains a large number of furnaces, steam hammers, etc., as shown by the list of tools herewith, and a wide assortment of the usual hydraulic and pneumatic tools. Heating is by hot air supplied overhead along the center of the building. The brass foundry occupies the west end of this building and is the only foundry provided for these shops.

Round House and Stores.

The round house stands to the west of the locomotive shops and contains 30 stalls, an emery wheel with a 3 h. p. motor and a turntable with a 7½ h. p. motor. It is conveniently located and locomotives can be turned in the desired direction here on the turntable before going into shops.

The storehouse stands north of the blacksmith shop, is three stories in height and 500 ft. long by 100 ft. wide. A 16 ft. platform runs along each side. The large supply platform at the east end of the building is served by a 5-ton crane. This has a span of 80 ft. and travels on a runway 400 ft. long, and covers one delivery track and a part of the platform. The oil houses and scrap platform are centrally located and are near the storehouse.

The storehouse is equipped with two electric elevators and a one-ton Sprague traveling I-beam hoist. There are also two pneumatic elevators. In the yards adjacent to the storehouse are two 5-ton traveling bridge cranes and a 4-ton gantry crane. Two lifting magnets of 1½ tons and ½-ton capacity, respectively, are used here for handling all sorts of parts by cranes. These magnets were made by the Electric Controller and Mfg. Co., Cleveland, O.

Miscellaneous.

The small woodworking department is located in the northwest corner of the locomotive shop now, but a completely-equipped planing mill is proposed when the car shops are built.

All of the buildings are heated by hot air blown in by fans, and sprinkler systems are provided for fire protection. All electric wiring outside of conduits is heavy weatherproof insulated. In the main shop, part of the wiring is exposed and part is in conduit.

The yards are lighted with arc lamps, there being 42 of these placed about the grounds. The office building contains 5 arc lamps, 80 incandescent lamps and 16 Cooper-Hewitt lamps. These are the only vapor lamps used.

Ventilation of the various buildings is accomplished by motor-driven fans, there being 4 of these in the locomotive shop, each driven by a 50 h. p. motor, one in the round house with a 35 h. p. motor, one in the blacksmith shop with a 35 h. p. motor and 2 in the storehouse with two 25 h. p. motors.

The writer wishes to express his appreciation of the kindness of Mr. G. W. Siedel, Supt. of Shops, and Mr. F. J. Glover, Chief Engineer, in assisting him to secure the information upon which this article is based.

LIST OF SHOP TOOLS.

------- Locomotive Shop ------

Machine	Size	Motor	Machine	Size	Motor
D.W.Lathe	79"	15hp	Tur.Lathe	16x6	2hp
D.W.Lathe	79"	15	Tur.Lathe	3"	10
D.W.Lathe	90"	55	Tur.Lathe	28x6	15
C.W.Lathe	42"	50	Tur.Lathe	32x12	5
C.A.Lathe	12"	15	Tur.Lathe	2"	3.5
Axl.Lathe	20x12	10	Tur.Lathe	18x10	5.
Lathe	36x12	5	Lathe	18x10	5.
Lathe	32x14	5	Lathe	18x10	5
Lathe	32x14	5	Tur.Lathe	34x4	10
Lathe	16x6	5	Port.Lathe		2
17 Lathes 2"to 15" in size Group ---- 25					
16 Lathes 16"to 20" in size Group --- 25					
8 Lathes 20"to 57" in size Group --- 25					
V.Bor.Mill	84"	10	V.Bor.Mill	60"	10
V.Bor.Mill	72"	7.5	V.Bor.Mill	42"	5
V.Bor.Mill	62"	7.5	V.Bor.Mill	42"	11
4 Bor.Mills		15	3 Bor.Mills		25
Planer	72x84	27	Planer	48x48	15
Planer	54x54	20	Planer	38x38	15
Planer	48x48	15	8 Planers	Group	25
11 Shapers	Group	25	Shaper	24"	7
Slotter	18"	15	Slotter	18"	5
4 Slotters	Group	15			
Mill.Mach.	18"	12	Mill.Mach.	24"	10
6 Mil.Machs.		15			
Rad.Drill	6'	5	Rad.Drill	4sp.	25
Rad.Drill	6'	10	Rad.Drill	4sp.	15
Rad.Drill	20"	1	25 Rad.Drills		35
Drill Grinder		3	Surf.Grinder		10
8 Emery Wheels		3	24 Grinders		15
Cyl.Borer		10	Wheel Press		7
Flue Rattler		25	Wheel Press		15
Punch		5	Stay Bolt Mach.		10
Punch & Shear		2	Cold Saw		14

------- Boiler Shop -------

Machine	Size	Motor	Machine	Size	Motor
Bend.Roll	14'	40	Punch	30"	8
Bend.Roll	86"	10	Drill Pr.	4 sp.	25
Stay Bolt Mach.		10	Blower	30"	15
Misc.Small Tools		15	Flue Rattler		25
Misc.Small Tools		25			

------ Blacksmith Shop ----

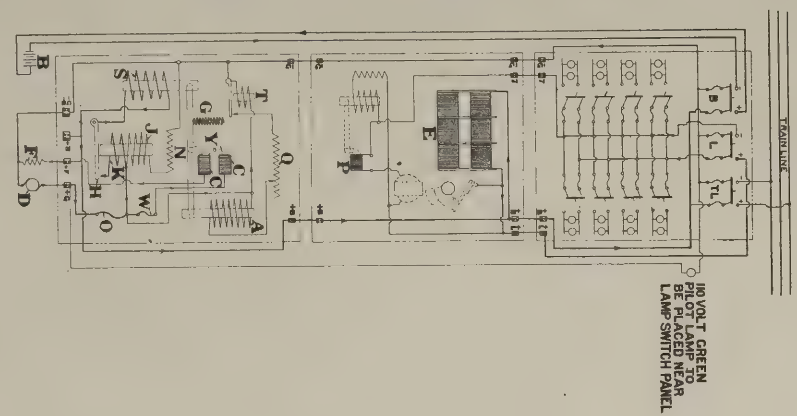
Machine	Size	Motor	Machine	Size	Motor
Bulldozer	#7	25	Punch & Shear		15
Arch Bar Dr.Pres		15	Shear		7
3 Blowers		40	Misc.Group		25
1 Steam Hammer	5000#		3 Steam Hammers	--- 1500#	
1 Steam Hammer	1600#				

DISTRIBUTION OF POWER

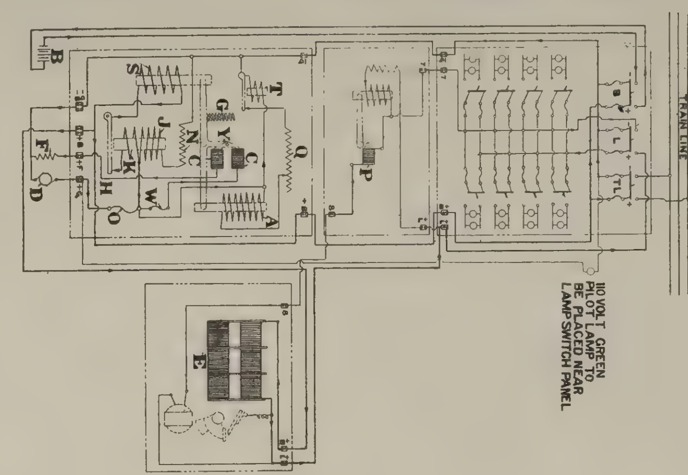
Department	Lighting			Motors					
	Incan-descent	Arc	Mercury Vapor.	Machine No.	Machine H.P.	Crane No.	Crane H.P.	Turntable No.	Turntable H.P.
Locomotive Shop	586	97	------	80	1100	30	310	---	----
Blacksmith Shop	53	24	------	7	127	--	---	---	----
Stores	433	8	------	3	70	12	40	---	----
Yards	---	42	------	--	----	--	---	---	----
Round House	152	3	------	1	35	--	---	1	10
Power House	169	12	------	2	10	3	20	---	----
Office	80	5	16	--	----	--	---	---	----
Miscellaneous	678	--	------	--	----	---	---	---	----
TOTAL	2151	191	16	93	1342	45	370	1	10

Wiring Diagrams of Safety Car Htg. & Ltg. Co's Axle Equipments

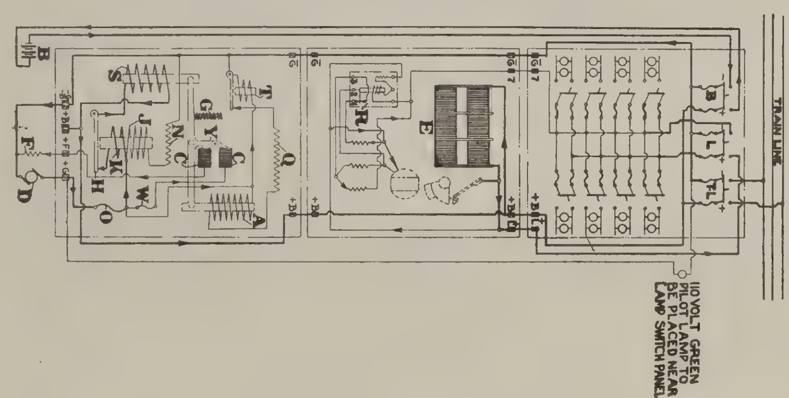
The Safety Car Heating & Lighting Company's Standard Type "D" Wiring Diagram with Lamp Regulator and Pilot in Car.



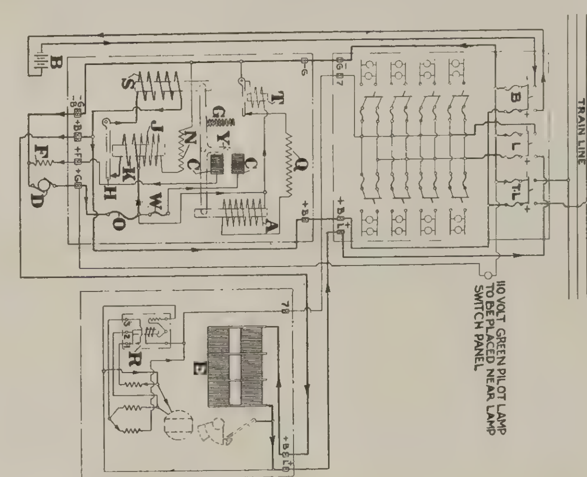
The Safety Car Heating & Lighting Company's Standard Type "D" Wiring Diagram with Pilot in Car and Lamp Regulator Under Car.



The Safety Car Heating & Lighting Company's Standard Type "D" Wiring Diagram with Lamp Regulator with Relay in Car.



The Safety Car Heating & Lighting Company's Standard Type "D" Wiring Diagram with Lamp Regulator with Relay Under Car.



General News and Personal Mention

CAR LIGHTING CLUB.

The Car Lighting Club met on Wednesday, October 18, at the Kuntz-Remmler Restaurant, 424 So. Wabash avenue, Chicago. About forty members were present to hear the paper on "Ampere-Hour Meters" presented by R. C. Lanphier, of the Sangamo Electric Company. This paper will be printed in the December number of the RAILWAY ELECTRICAL ENGINEER. Mr. Lanphier described the design and manufacture of these meters as carried on in the plant of his company and mentioned a number of uses to which they are being put, dwelling especially on their use in handling railway car lighting batteries. His talk was illustrated by views of the meter thrown on a screen with a stereopticon lantern.

One of the interesting improvements recently made in the meter is a device by which the scale can be removed any distance desired from the meter. This means that the scale can be mounted inside the car at the most convenient point while the body of the meter can be placed under the car. Mr. Lanphier also described a number of novel uses to which the meter has been put, such as the control of silver plating baths and of the baths which deposit the nickel and nickel hydrate used to form the positives of the Edison storage battery. A large electric railway company in New York has a meter which reads in amperes^2-hours hours. This, multiplied by the resistance of the company's cables, gives the heating loss directly.

Several members of the club testified to the good results attained by using this meter for car lighting. Mr. Gilman (C. M. & St. P.) said that it has a very good moral effect upon the men having charge of them and that the fact that some accurate record can be kept tends to increase the interest they take in their work.

In regard to the testing of meters, Mr. Lanphier said that meters which are depended upon for records should be tested at stated intervals varying from one week to one year, according to the type of meter and the kind of service.

After the business session was over there was a short social session much enjoyed by all present. The consensus of opinion was that the Car Lighting Club is a good place to acquire stories. General satisfaction was expressed with the new meeting place.

The next meeting will be on Wednesday evening, Nov. 8, at the Red Room of the Hotel La Salle, when the entertainment for the Association of Railway Electrical Engineers will be given. Through the efforts of W. M. Lalor, the clug has been able to secure Mrs. Morgan S. Woodward, who will tell of her experiences while a guest of the American Legation at Pekin during the Boxer War in China. Invitations to be present at this meeting are being sent to many prominent railway officials, and it is hoped that all club members will make it a point to attend and bring their ladies.

The December meeting will be held Dec. 20 at the regular meeting place. The subject for the evening will be "Electric Headlights."

Among the orders recently received by the Edison Storage Battery Company are one for 16 sets of train lighting batteries for the Florida East Coast Railway and one for 10 sets of train lighting batteries for the New York, New Haven & Hartford Railway.

A NEW EXTENSION CHARGING PLUG AND RECEPTACLE.

The most recent developments in devices designed to afford a ready means of connecting portable tools, lamps, batteries or other translating devices to the power or lighting circuits, is the Type "R" plug and receptacle illustrated herewith.

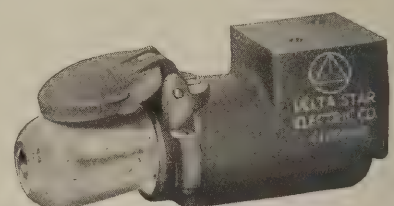
In general the considerations involved in the design of plugs and receptacles are as follows:

1st. To provide means for carrying the rated current of the device without excessive drop or heating.

2nd. To carry such overloads as may be encountered in actual practice.

3rd. To insulate all live parts for maximum potential in a permanent manner both electrically and mechanically.

The designers of the device shown, have given all these features most careful consideration with the re-



Delta-Star Extension Charging Plug.

sult that a type has been developed in which many of the weaknesses of the older forms have been eliminated.

The receptacle consists of an iron shell containing two flat contacts mounted in a fireproof insulating body impervious to moisture, acids or oils. This material has high insulation and mechanical strength, rendering impossible short-circuiting between the terminals. The receptacle can be mounted on a horizontal, vertical or angular position as desired.

The plug consists of a metal shell containing two flat contacts imbedded in insulating material, and so designed that they hook into the receptacle contacts preventing accidental opening of the circuit.

All parts are made with dies insuring interchangeability, a very essential feature in railroad service. This new device will be found of great value in railroad shop or train lighting and signal work where a permanent highly durable construction is essential.

NEW MEMBERS.

Since last report the following new members have been added to the roll of the Association:

Warren M. Beardslee, 632 Terrace Ave., Grand Rapids, Mich.

John E. Eipper, 4322 N. 41st Ave., Chicago.

M. R. Garnett, 7244 Lexington Ave., Chicago.

Allen Gidley, C., R. I. & P. Coach Yards, Council Bluffs, Ia.

G. G. Harris, 1512 E. 66th Place, Chicago.

John Lahndorff, 11731 Dearborn Ave., Chicago.

James B. McIntosh, Union Station, Washington, D. C.

Howard A. Stofflet, 1035 N. 5th St., Reading, Pa.

RAILWAY ELECTRICAL ENGINEER

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

THE CONVENTION IN RETROSPECT.

Looking back on the Fourth Annual Convention of the Association of Railway Electrical Engineers, which has now slipped two weeks into the past, two things stand out clearly. One is that more actual business was done in less time than at any previous convention; the other that the entertainment features were handled more smoothly.

For the first, due credit must go to President Sloan. He has shown how much a strong executive can do to keep things moving and bring about definite results. There is always a tendency at these meetings to drift away from the point and lose the thread of the discourse in a cloud of personal reminiscences which, while interesting, are rarely pertinent. This tendency can be overcome by the chairman, who insists on the speakers confining themselves to the subject before the house, as was done by President Sloan. The larger the association becomes, the more necessay is strict adhrence to such a course.

Better organization and stricter settling of responsibility together with the experience gained at former conventions explains the improvement in the handling of the entertainment features, in which we mean to include the exhibits. It is hard to see how the convention as a whole could have been much better run.

It may be borrowing trouble but there appeared to us a possible danger that the entertainment features may come eventually to overshadow the business or technical side of the convention which is the fundamental reason for its existence. Such a condition has actually occurred in the M. C. B. conventions at Atlantic City with the result that in 1912 all entertainment stunts except the baseball game will be tabooed and informal hops will be substituted for the formal dances. There was even some difficulty from this source this year at our convention. For a great many members the exhibit hall proved a stronger magnet than the convention hall. It may not be feasible but it would certainly be a good thing for the Association if the exhibit hall could be closed during the sessions. We do not believe this would work any serious hardship on the exhibitors. It was done last year, when the meetings were held in the same room with the exhibits. A ruling of this sort would come gracefully from the Supply Manufacturers Association and would be a courtesy to the Engineers' Association which we are sure would be appreciated.

Having now expressed what seems to us the only possible criticism of the conduct of the convention, we join in the universal praise of its management and for ourselves—we had the times of our lives.

VENTILATION.

Dr. W. A. Evans in his interesting talk on ventilation at the recent convention said that railroads should have a thousand times as many ventilating fans as at present. Of course, we know this is a rather enthusiastic statement, but there is, nevertheless, a great truth here which should not be overlooked and one which the railroads cannot ignore much longer. That is, that the present system of ventilating railway cars is little short of barbarous. It is the worst kind of folly to expect that any system of ventilating introducing cold, unheated air at the roof of the car, this falling directly on the heads of the passengers, will provide any degree of comfort.

The Pennsylvania Railroad has been doing some pioneer work along this line recently in providing vent-ducts leading from a hood ventilator in a roof down through the car ceiling and walls to outlets behind the steam coils. This does very well when the car is in motion, though the ducts do become clogged with cinders, but when the car is at rest the duct ventilation is practically nil. This is due to the length and number of curves in the pipe as well as its small cross-section.

Dr. Evans recommends a system which takes the air directly through a large hole in the floor or side of the car immediately below the steam coils. On first thought one would say that this would be a rather dusty proposition for the traveling public. But experience in electric railway operation has proven that the prevalance of dust beneath passenger cars has been rather overestimated by all of us. Electric railways operating six and eight-car trains use this system today and experience no discomfiture from dust.

As the cross-section of the vent duct in this case could be very large and its length practically nothing, a good natural draft would result which would provide proper ventilation of the car both while standing in the station and at high speed on the road. It may be found feasible and possibly necessary to install some sort of air washing or cleaning device to eliminate smoke, dust and cinders. That, however, is a detail which experience will no doubt take care of.

The December meeting of the Executive Committee of the Association will be held at 2 p. m. Wednesday, December 20th, the same day as the Car Lighting Club, in the General Offices of the Lake Shore Railroad, La-Salle Street Station, Chicago.

The December meeting of the Car Lighting Club will be held as usual at 6:30 p. m., Savage Club, Kuntz-Remmler's Restaurant, 424 South Wabash Ave. The subject of the evening will be, "Electric Headlights." Mr. J. Will Johnson of the Pyle-National will open the discussion and A. I. Totten, of the General Electric Co., will tell us of the recent developments on storage battery headlights.

F. R. FROST.

Mr. F. R. Frost, recently elected president of the Association of Railway Electrical Engineers, has for the past ten years been one of the most active workers of the country in developing the art of electric lighting of railway cars. Since the organization of the Association he has been one of its main foundation stones

F. R. Frost.

and for earnest effective work few have been his equal.

The Santa Fe was the first railroad to equip any large number of cars for axle lighting, in fact, the installation of fifty cars with the old Moskowitz system marks the beginning of the art as it is known today.

Mr. Frost began this worldly hustle in 1870 at Ithaca, N. Y., and, after the regulation training in city schools, was graduated from Cornell University as M. E. in 1893. This, if you remember, was about the time of the World's Fair at Chicago, and Mr. Frost spent a few months in the testing department of the Bureau of Awards. Later he took up a special study of alternating current phenomena at Cornell University, which he supplemented with a student course at the Westinghouse Electrical Works.

In this work he soon developed to foreman of the Testing Department and this position he held for four years. He then became traveling and erecting engineer for the same company and continued in that capacity for two years.

In 1901 he was appointed to the position of Electrical Engineer of the Atchison, Topeka & Santa Fe Railway, and this brings him down to where we all know him. His work in systematizing costs and improving methods of car lighting, and his pioneer work in proving to the railroad world that the illumination

George H. Porter.

of railway cars by electricity was not only possible but a practical, economical and effective system, cannot be overestimated in an analysis of railway carlighting.

GEORGE H. PORTER.

Mr. George H. Porter, just elected president of the Railway Electric Supply Manufacturers' Association, is one of the livest scouts in the railroad supply game. His work as vice-president in taking charge of all arrangements for the last convention in the absence of President Moore, permanently located in New York, stamps George as being not only the smiley-clad good fellow that we have always known him, but a mighty effective executive as well.

Mr. Porter in his joyous boyhood days, not however in contra-distinction to his present activities, went through a very complete course of sprouting at the Mount Pleasant Military Academy at Ossining, N. Y. It's our guess that this is what gave George his military (?) bearing.

After this he spent a few years on a browbeating expedition through the South for the Standard Electrical Company and supplemented this with some more work of a similar nature out of the Columbus office of the Electric Appliance Company.

Western Electric Company got him about four years ago and Western Electric stock has been going up ever since. He is now manager of their Railroad Sales Department.

It's about as one of his friends has said, that George is "a living example of the joy of living." But that is not all, he is one of the livest of the "live wires," and the Manufacturers' Association should count itself mighty fortunate that it has such a bunch of energy and ability in its official head.

D. J. C.

F. R. F.

Fourth Annual Convention of the Association of Railway Electrical Engineers

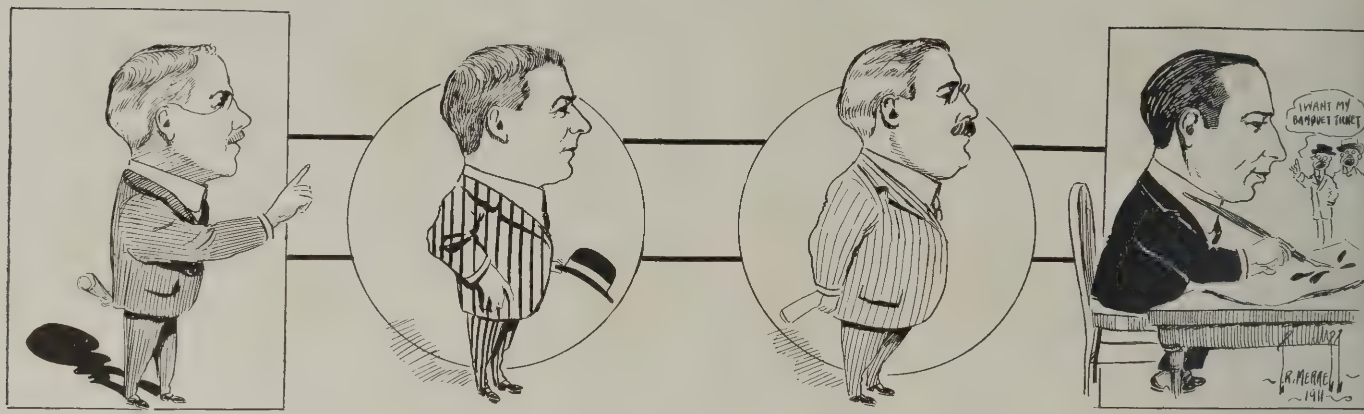
Hotel La Salle, Chicago, Nov. 6-10, 1911

MORNING SESSION, NOV. 7.

The opening session was called to order by President Sloan at 10:30 Tuesday morning, Nov. 7. The first business was the address of the president. Mr. Sloan mentioned the work of the Illuminating Engineering Society, referring especially to the course of lectures on illuminating engineering given at Johns Hopkins University in Baltimore. He said the Association of Railway Electrical Engineers had received recognition from this organization and from the National Electric Light Association which should be gratifying to the members. He also called attention to the work of the Bureau of Standards of the Department of Commerce and Labor, and said an invitation had been extended to all members of the Association to be present at its conferences.

Fourth Annual Banquet Association of Railway Electrical Engineers.

The president complimented Secretary Andreucetti on



C. R. G. A. I. T. W. L. B. G. R. B.

the improvement in the financial condition of the Association, which he thought was largely due to the efforts of the secretary. He said that the work of the committees was excellent, but too much of it was being done by a few men. He urged all members to enter enthusiastically into this work and said that "work for the Association and the furthering of its aims will be, at the same time, work for the railroad which you represent and for yourself individually."

A communication from Mr. L. Gutmann of the St. Louis Section of the American Institute of Electrical Engineers relative to improvement in the patent laws so as to give better protection to inventors was read. A motion approving legislation in this direction was passed after being favorably commented upon by Mr. Farrelly (C. & N. W.).

A communication from W. A. Del Mar of New York, asking for the co-operation of the Association in securing a standard terminology for wires and cables, was read. A motion declaring the Association in favor of the standard terminology to be decided upon by the A. I. E. E. was carried.

REPORT OF THE SECRETARY-TREASURER.

Receipts.

Cash in bank on assuming office	$ 45.27
Received for dues	1,229.34
Received for advertisement in Proceedings (1910)	490.00
Received for emblem buttons	72.72
Received for Proceedings	2.50
Total	$1,839.83

Expenditures.

Stationery and printing 1910 Proceedings	$ 566.54
Stenographic report 1910 convention	154.00
Stenographic report semi-annual meeting, 1911	68.21
Emblem buttons	121.60
Postage	134.98
Balance of salary due secretary for 1910	12.62
Salary secretary-treasurer 1910 and 1911	200.00
Miscellaneous and exchange on checks	4.95
Total	$1,262.90

Membership to Date.

Honorary	20
Senior Active	170
Junior Active	137
Associate	224
Total	551
Total receipts	$1,839.83
Total expenditures	1,262.90
Balance in bank	$ 576.93

An amendment of Article IV of the constitution providing for payment of dues for the ensuing year immediately after each annual convention was proposed by the secretary. It was explained that this would greatly facilitate the collection of dues and avoid misunderstanding as to the period which the dues should cover. After a short discussion this amendment was carried.

An amendment to Article VIII of the constitution in regard to voting on standards was proposed. The procedure under the new article is substantially as follows: Any proposed standard for material, construction, or practice, must be submitted to the Association as a whole at its annual meeting after being published in advance. A vote of the active members present will then be taken. If this vote is favorable the proposition is to be submitted to the ranking senior active members of the railroads represented in the Association by letter ballot within three months of the convention. These members are to vote one vote each for the number of electric lighted cars on the road of each, this number to be the number in service on June 1st previous to the vote. It is further provided that all propositions submitted to the Association in convention assembled must first have the approval of the executive committee.

There was a long discussion as to this amendment. D. B. Pastorius (Penna.) argued that it did not give all members sufficient opportunity to express their preferences. D. J. Cartwright (Lehigh Valley) showed that the provision for deciding at the convention what reports are to be submitted for letter ballot overcomes this objection. The value of the method in expediting business was considered by President Sloan an important point in its favor. It was pointed out that members could confer with the ranking member on their respective roads and thus have their opinions receive due consideration. The amendment was carried.

AFTERNOON SESSION, NOV. 7.

The report of the Committee on Data and Information was read by F. E. Hutchinson (Rock Island), chairman. This report and all other committee reports hereinafter mentioned were published in full in the November issue of the Railway Electrical Engineer. Mr. Hutchinson was called upon to explain the curve included in the report, showing proper setting of stop charge devices for various charging rates. With regard to the statistics on electric lighted cars, he said he believed them to be practically complete. The report was accepted as read.

The report of the Committee on Ventilation was next called for. In the absence of E. M. Cutting, chairman, F. E. Hutchinson was asked to read the report. Mr. Hutchinson said that the article on Ventilation in the Railway Electrical Engineer, although written by Mr. Cutting, could not be taken as a committee report on the subject, since it had not been seen by the other

George. W. H. G. Johnny C. Hutch.

members of the committee and did not express their views. It seems that Mr. Hutchinson, upon request of Mr. Cutting, had acted as local chairman of the committee and gathered some material from the other members. This material he had forwarded to Mr. Cutting, but the report of Mr. Cutting was not based upon it. It was decided to dispense with the committee report and hold an informal discussion on the subject of Ventilation.

The first speaker was W. H. Lynch of Chicago, said to be a ventilating engineer. Mr. Lynch talked at great length on the subject of ventilation. He discussed it pro and con, fore and aft, up and down and in many other ways. He was careful, however, not to suggest any definite plan or method and contented himself with generalities.

Dr. Evans on Ventilation.

Dr. W. A. Evans, formerly Health Commissioner of the city of Chicago, was next called upon. Dr. Evans said that he had done considerable work on car ventilation with particular reference to street cars. There are now strict city ordinances requiring the ventilation of street cars to be up to a certain standard. These may not apply to steam railway cars on account of the latter being used for interstate traffic. However, it is almost certain that national enactments on car ventilation will soon be made.

In Dr. Evans' opinion, the problem of ventilating a railway car is not so perplexing as many seem to think. To get good ventilation in a car it is necessary simply to have a steady stream of fresh air pass into the car and by the people in it. This air must be as pure as possible and it must be warmed before entering the car. It is folly to talk of introducing air at outside temperatures and allow the passengers to warm it up with their lungs. The air should be introduced at a temperature between 65 and 70 Fahr. It is just as bad to have it above this temperature as to have it below.

On account of the shape and construction of a car and the fact that it is moving through the air at high speed, cooling and surface condensation are much greater than in any other rooms. However, this need not cause any trouble.

The Pennsylvania Railroad system of car ventilation is essentially the correct system. This system takes out the air at the ceiling and introduces fresh air at the floor. This fresh air, however, is taken in above the roof and led to the floor through ducts. Heating pipes are placed in the ducts.

There are two objections to this system. First, a great many cinders get into the ducts, eventually clogging them up; second, the system is not effective when the car is standing still. If the length of the ducts could be shortened it would be an improvement. In fact, it might be possible to eliminate the ducts altogether and take the air from under the car. This is done on the Chicago street railway cars and on the elevated cars, which latter are run on the ground for considerable distances. In Dr. Evans' opinion there is no more dust under the car than around it or above it. Even if there is, it would be better to take the air direct and use some means for extracting the dust.

Dr. Evans said he was a great believer in the use of fans for agitating the air. It is just as important to keep the air moving past the body as to change it at regular intervals. Fans would greatly improve many poorly ventilated places. They should be run the year round. An exhaust fan properly placed would make a car fitted with the Pennsylvania system well ventilated at all times.

Mr. Farrelly asked if the ozone machines were useful and practical substitutes for ventilation. Dr. Evans said that these machines were rather inefficient. They make only a small quantity of ozone. Ozone is oxidized oxygen. It is a question whether this has a good effect on human beings. Nitrous oxides which are positively harmful are also made by ozonizers. Ozone has the property of destroying odors, and since man's nose is his best guard against bad air, this property is not altogether in its favor.

C. R. Gilman (C., M. & St. P.) called attention to the fact that there are as many standards of good ventilation as there are passengers, and that it is a hopeless task to try to suit everybody. The best that can be done is to set a standard and educate people to agree with it.

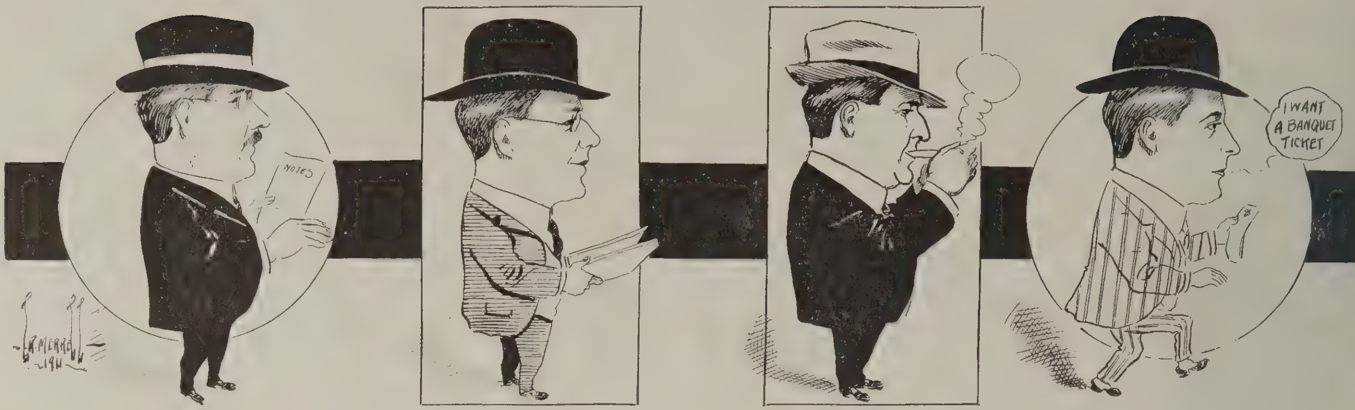
MORNING SESSION, NOV. 8.

The report of the Committee on Standards was read by D. J. Cartwright, chairman. Several minor corrections were noted. Objections were made to paragraphs 6, 7, 11 and 21. On motion it was decided to refer all other sections of the report to letter ballot.

Paragraph 2 prescribes that all head end cars must be equipped with train lines, as must all cars furnished to foreign lines, and gives standard methods for wiring. W. J. Bohan (Northern Pacific), A. J. Farrelly and C. R. Gilman spoke in favor of requiring all electric lighted cars to be equipped with train lines. N. E. Lemon (Pullman Co.) and D. J. Cartwright opposed any change in the recommendation. It was decided to submit paragraph 2 as printed to letter ballot.

Paragraph 5 (b) requires the charging plug and receptacle to be interchangeable with the Anderson type "A." It developed that this leaves the field open for other manufacturers to make charging plugs conforming to the standard, and the paragraph was passed for letter ballot.

Paragraph 6 requires two 150-ampere fuses to be close connected to each battery terminal. This recommendation was opposed by A. J. Collett and N. E. Lemmon



N. E. L. H. E. H. B. F. F. A. C. M.

and supported by D. J. Cartwright and C. R. Gilman. After a long discussion the recommendation was amended so as to omit "150-ampere," leaving the size of fuse to the discretion of the electrical engineer. Thus amended paragraph 6 was passed for letter ballot.

Paragraph 7 was objected to only on account of a misunderstanding. With this cleared up, it was passed for letter ballot.

Paragraph 11 recommends 30 volts (nominal) for axle lighting and 60 volts (nominal) for head end lighting. C. R. Gilman and W. J. Bohan favored making 60 volts standard for all train lighting. This was opposed by N. E. Lemmon and others. W. L. Bliss explained the advantages of the 30 volt system—stronger lamps and fewer cells of batteries to care for. He was of the opinion that head end lighting could be operated satisfactorily at 30 volts if necessary, and thought the difference between 30 and 60 volts too slight to cause serious trouble when running both in the same train. After much discussion the paragraph was passed for letter ballot.

Paragraph 21 specifies the types of terminals for various fuses. L. S. Billau raised the question as to whether these did not limit the roads in the choice of fuses best suited to the purpose, but as it was shown that the recommendations had been practically standard for many years, the paragraph was passed for letter ballot.

It was arranged that letter ballot voting should be done on each paragraph instead of on the report as a whole.

AFTERNOON SESSION, NOV. 8.

The report of the Committee on Shop Practice was read by A. I. Totten. A. J. Farrelly spoke of the importance of looking ahead for future long distance transmission from small plants, and cited a particular case where power originally planned for 300 feet transmission eventually had to be transmitted over 3,000 feet. For such cases there is great advantage in using alternating current. Mr. Farrelly expressed a belief that there is no railway requirement for which alternating current is not at least as good as direct current.

F. E. Hutchinson maintained that for certain purposes direct current was much superior—notably in machines which are operated over a wide range of speed for various classes of work.

Mr. Collett asserted that experiment in the Union Pacific shops had demonstrated the superiority of the direct current motor for certain shop tools.

The report was accepted.

The report of the Committee on Improvements was then read by Edward Wray. The report was accepted.

Some discussion in regard to postal car lighting followed. C. R. Gilman pointed out the desirability of standardizing on as few types of shades as possible, and said that the use of auxiliaries of known inefficiency should be discouraged.

D. J. Cartwright said a conference of car builders with the postal authorities had been called, and it was probable that some standard lighting arrangements would be settled upon at this meeting. At present postal car lighting must be done to suit the local postal authorities, with the result that there is a wide variation in the equipment in use. Postal cars require a large amount of light for a long time. The use of two 16-cell sets of batteries on the car was recommended by Mr. Cartwright. He also considered the Alba shade well adapted to this work.

A paper on "Moulded Electrical Insulations" was read by Kurt R. Sternberg. A vote of thanks was extended to Mr. Sternberg and a short discussion followed.

MORNING SESSION, NOV. 9.

A paper on "The Light for Safety," written by F. R. Fortune, was read by George C. Keech. This paper was published in the November issue of the Railway Electrical Engineer. In commenting on this paper, Mr. Keech took issue with the author in regard to the intensity of artificial light under which it is possible to work without visual fatigue. Mr. Keech thought that 40 or 50 foot-candles was as strong illumination as could be used to advantage. He thought that quality or color of light is more important than total flux or distribution. Too great intensities are often used, resulting not only in poor illumination but in high costs.

In regard to quality of light, Mr. Keech said the paper meant that we can read one and one-half times better by monochromatic light than by the same amount of light from a continuous spectrum. This was demonstrated by Dr. Bell by a long series of experiments. Mr. Keech was of the opinion that high intrinsic brilliancy of modern illuminants such as the carbon arc, flaming arc and the Nernst glower is largely responsible for the eye trouble prevalent today.

Mr. A. J. Sweet said that the table of intrinsic brilliancies given by Mr. Fortune is well authenticated and can be accepted as correct. However, it has very little bearing on practical conditions of illumination. For instance, the intrinsic brilliancy given for the tungsten lamp is that of the bare filament, whereas in actual practice this lamp is also always used with shades or reflectors, which tone down the brilliancy to a proper figure.

Mr. Sweet also took exception to Mr. Fortune's treatment of the subject of glare. The term glare is used to mean several different things. Mr. Fortune has taken it for granted that the bad effects of glare are due entirely to high intrinsic brilliancy. This is not the case and Mr. Fortune's deductions were therefore, in the opinion of Mr. Sweet, incorrect. How-

D. Mc K. H. H. F. D. George M. C. E. B.

ever, the mercury vapor lamp is a very useful light source, and there is no doubt but what monochromatic light is very satisfactory. It is unfortunate that the shape and size of this lamp have so far prevented the development of satisfactory reflector for use with it.

Mr. Keech said that there was very little need for such a reflector, and that the light was not at all injurious to the eyes of people working under it. However, there is no reason why such a reflector could not be developed if it were considered necessary.

D. J. Cartwright (Lehigh Valley) asked if it is well to use incandescent lamps and mercury vapor lamps together. Mr. Keech said there is no objection to doing this, but it is very seldom necessary.

In regard to the effect of the light from a mercury vapor lamp on the eye, Dr. C. P. Steinmetz was quoted to prove that injury to the eye is due to the energy effect of the orange and red rays, which rays are almost entirely lacking in the light from the mercury vapor lamp.

Specifications.

The report of the Committee on Specifications was read by F. R. Frost (Santa Fe). That part of the report covering electrolyte for lead batteries was approved and is to be submitted for action by letter ballot. The specifications for a hard-drawn copper wire omitted from the report published in the November issue were presented by Mr. Frost and approved for action by letter ballot. These specifications are the same as those adopted by the American Society for testing materials.

It was decided to continue the committee on specifications for incandescent lamps for another year. The specifications for rubber-covered wires were not satisfactory, and it was decided that the committee on specifications should make another study of this subject and report again at the next convention.

Train Lighting Practice.

The report of the Committee on Train Lighting Practice was read by L. S. Billau (B. & O.). In regard to the number of batteries required in head end lighting, Mr. Billau explained that on his road the trains are largely remade during their run between Chicago and Jersey City, and that the rather steep grades necessitated the shutting down of the turbo-generator during a considerable part of the time.

Mr. Farrelly said that under ordinary circumstances there was no reason for shutting off the turbo-generators, and that as a matter of economy in battery equipment, they should be run practically all the time that the locomotive is attached to the train.

R. A. Wallace (C., St. P., M. & O.) cited a trouble he had had with the engineers, but said that a little insistence would get the desired result. As to whether it is desirable to have two steam lines between the locomotive and the train, one for the turbine and one for heating, A. J. Collett (U. P.) said that he had tried both systems and found that one line was cheaper and better than two. Mr. Farrelly was in favor of using metallic hose instead of rubber hose for steam connections. It is more reliable and will stand higher steam pressure. Most of the trouble with metallic connectors, according to Mr. Billau, is due to the couplings. Mr. Gilman said that rubber hose connections have been entirely satisfactory on his road, and while there had been a certain number of failures, the expense of equipping all cars with metallic connections was regarded as unwarranted.

Mr. Collett said that a general order should be issued requiring the dynamo car to be placed next to the locomotive. This is done on the U. P. and saves a great deal of trouble with steam connections.

Mr. Gilman said that with a 64-volt system he did not care where the dynamo car was placed. In fact, if there were "blind" cars in the train, it is better to have them ahead of the dynamo car than behind it, as they would make it impossible for the electrician to get back into the train.

In regard to automatic regulators in each car, these are very fine in theory, but rather disappointing in practice on account of the delicate mechanism required. Such regulation is, in the opinion of Mr. Gilman, entirely unnecessary with the head-end system.

Further discussion in regard to steam connections developed the fact that the life of rubber hose varies from three weeks to two months. The use of the 64-volt system reduces the load on the generator about one-third, which greatly reduces the steam pressure required and consequently does away with much of the trouble from bursting hose.

THURSDAY AFTERNOON SESSION.

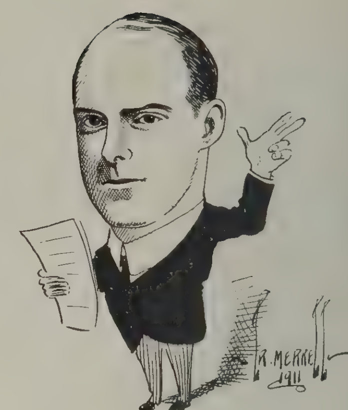
The report of the Committee on Illumination was read by C. R. Gilman, chairman. In discussing this report, B. F. Fisher said that although great improvements have been made in the tungsten filament, they are nevertheless more or less brittle, and the impression should not be given that tungsten lamps will stand careless handling. The tungsten filament has a tensile strength higher than carbon, but this does not mean that it is stronger in service. The increased strength of the tungsten filaments of today over those of a few years ago is chiefly due to the fact that they are now made in one piece instead of being fused into the support.

It should be borne in mind that since its efficiency

This Is All George Shirk Would Let Us Do for Him.

Van.

Jack S.



E. W. J.

is the greatest advantage of the tungsten lamp, and the higher the cost of current, the greater will be the advantage of using it, but even if there were no charge at all for current, it is more economical to use the tungsten than the carbon.

In reply to a question by Mr. Hutchinson, Mr. Fisher said that the effort on the part of the manufacturers has been to increase the efficiency rather than to increase the life of the lamps. He predicted the development of a one-watt per candle tungsten lamp in the near future. The variation of candlepower with voltage is less for the tungsten lamp than for the carbon. Mr. Fisher thought the use of 34-volt lamps, with a regulator set to maintain the voltage of 31, was a good arrangement on account of the impossibility of very close regulation in car lighting.

With regard to the relative merits of a lamp regulator and a protective resistance, A. McGary (N. Y. C.) said that actual experience had proven the lamp regulator to give much better results. In this connection Mr. Fisher mentioned the variable resistance lamp invented by Dr. Buttner, in which the resistance increased rapidly with increased current.

It was pointed out that in all regulating devices the change in resistance follows the change in current, but operates so rapidly as to be practically instantaneous.

The general sentiment seemed to be that the use of lamp regulators is very desirable from the standpoint of economy as well as to maintain satisfactory service. On motion of Mr. Hutchinson the report was accepted.

The report of the Committee on Accounts and Reports was read by F. R. Frost, chairman. L. S. Billau pointed out that while the form is excellent for comparative purposes, it does not conform to the system of account required by the Interstate Commerce Commission.

Mr. Frost said that all of the expenses for car lighting could come under two accounts, Train Expenses and Car Repairs. Mr. Cartwright thought some provision should be made for expenses incurred on account of wrecks.

Mr. Hutchinson pointed out that this report is intended for use in engineering departments, and there is no practical reason why it should be altered to conform to the Interstate Commerce Commission's requirements.

The first four items in the report may be included or omitted at the discretion of the man using it. After considerable discussion it was decided that while it was probably necessary for the accounting departments to make their reports conform to the Interstate Commerce Commission rules, there is no such need in this report, which is intended only to secure a comparison of the cost of different operating items on various roads. The report will be submitted for approval by letter ballot.

Edward Wray offered to supply copies of this form to all chief electricians who desired to use them.

MORNING SESSION, NOV. 10.

A paper on "Industrial Trucks for Railway Service" was read by the author, T. V. Buckwalter, of the Pennsylvania Railroad.

In discussing this paper Mr. Buckwalter said that the tonnage handled per day varies considerably with the class of material, but will average 250 tons per day. The average load is 2,100 pounds; the maximum load, 5,700 pounds. Rubber tires are necessary for safety. All battery charging is done with the batteries off the car. In this way the truck can be used practically 24 hours a day if desired. Changing batteries takes only two minutes. Four hours' charging at the 40-ampere rate will run the trucks 48 hours. The mileage is from 8 to 16 miles per day. Both Edison and lead batteries are used with good results. If the Edison battery is indestructible it would be economy to use it, as a life of five years is guaranteed. A lead battery should last two or three years. The Edison batteries used were specially designed and take small space. Mr. Buckwalter believed a 24-volt equipment better than one operating at a higher voltage on account of the reduced weight and simpler control. The motor used will carry 30 amperes continuously, but will take care of 200 amperes without excessive sparking.

Mr. Buckwalter said that more than half the train detentions are due to delays in baggage and mail loading. These are very largely done away with by the electric truck.

The Auditing Committee reported that the books of the Secretary-Treasurer had been audited and found correct. The report was accepted.

It was decided to hold the next annual convention in Chicago in the fall of 1912, the exact dates and place to be left to the discretion of the Executive Committee. The next semi-annual convention will be held in Atlantic City, N. J., on the day previous to the opening of the convention of the Master Car Builders' Association. This will bring the convention on Tuesday, June 11, 1912.

An amendment to Article VIII, Section 1, of the constitution, allowing official action to be taken at the semi-annual convention as well as at the annual convention, was carried.

President Sloan called attention to the necessity of adopting a standard for ball bearings on axle generators. It was decided to appoint a committee to look

Major A. A. W. E. B. A. J. S. Bender.

into this matter and recommend standard dimensions for ball bearings for axle generators.

Election of Officers.

The next business was the election of officers for the year 1911-12. The following were elected:

President—F. R. Frost.

First Vice-President—D. J. Cartwright.

Second Vice-President—C. R. Gilman.

Secretary-Treasurer—Jos. A. Andreucetti.

L. S. Billau and E. W. Jansen were elected members of the Executive Committee to take the place of C. R. Gilman and A. McGary, whose terms expired.

A vote of thanks for the entertainment features at the convention was tendered to the Railway Electric Supply Manufacturers' Association.

THE BANQUET.

The Fourth Annual Banquet held on Thursday evening proved the best ever. Arrangements were made whereby groups that knew each other were seated together at the tables, which added greatly to the enjoyment of the occasion. Mr. Frederick P. Vose presided as toastmaster. Mr. Vose has a big reputation as an expert executive for functions of this kind and he added to it materially. His introductory speech on "Nothing" will never be forgotten by those who had the pleasure of listening to it.

Mr. Vose said that since no subjects had been assigned to the speakers, the program for the evening seemed to be "Nothing." However, there was no need for alarm, for "Nothing" is a good subject. He then proceeded to demonstrate the truth of this statement and amid a roar of applause introduced the first speaker, Mr. W. L. Park, Vice-President and General Manager of the Illinois Central Railroad.

Mr. Park thanked the toastmaster for having left nothing of the time. He complimented the Association on its work, but sounded a word of warning against expecting too much from the railroads in too short a time. The public, he said, is getting to believe that the railroads can do anything, and while tremendous progress has been made in the last few years, it is folly to expect the impossible.

President Delano of the Wabash was the other speaker. He commented favorably upon the use of electricity on the railroads and said that the future was certain to see its applications still further extended. However, the new thing is usually overrated. When the sailing vessel was devised, men said that soon there would be no more rowboats. When the steamship came along it was freely predicted that the sailing vessel would soon disappear. Yet the rowboat is still much used and sailing vessels carry a large proportion of the tonnage of the seas. People have been lamenting the passing of the horse with the advent of the steam locomotive and the automobile, but there are more horses today than ever before in history. Hence it is not probable that the electric locomotive will entirely supersede and do away with the steam locomotive. Nevertheless there are many situations in which the electric locomotive will have a tremendous advantage. Mr. Delano said that it was his own notion that when Mr. Edison really perfects the storage battery in the way he has started to do, and can give a storage battery with endurance without excessive waste, many branch lines will be operated with that form of motive power.

Mr. Delano also looked favorably upon the gas engine and thought it might play a large part in the future of electric power on the railroads. He saw an opportunity to greatly increase the efficiency of air driven tools by doing away with long pipe lines for compressed air transmission and locating small electrically-driven compressors near the tools, or by developing similar tools driven direct by electricity.

ENTERTAINMENT.

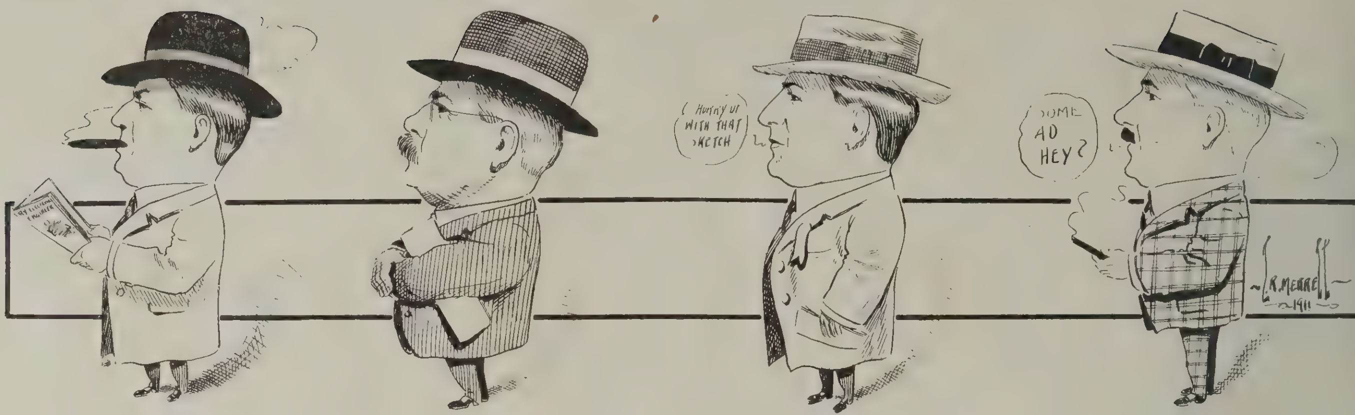
Most important among the entertainment features were the dances on Monday and Thursday evenings, the banquet, the Car Lighting Club entertainment, the theater party and the automobile tour.

The two dances were greatly enjoyed by a crowd that was almost too large even for the big ball room at the La Salle. Monday night's crowd was much larger than that at the opening last year. The Thursday night ball started at 9:30 after the banquet and lasted till 2. The success of these two delightful affairs is due to the efforts of W. M. Lalor, who, on account of an injury received while working Monday on the Gould exhibit, was unfortunately unable to attend the first.

The banquet, which is mentioned in another place, was highly successful in every respect, through the efforts of the banquet committee, of which George R. Berger was chairman.

The Car Lighting Club entertainment—an address by Mrs. Morgan S. Woodward on her experiences during the siege of Pekin—attracted a very large and select audience and was voted one of the best evenings of the week.

The theater party on Wednesday afternoon—"Over Night," at the Princess theater—and the automobile tour on Tuesday afternoon were greatly appreciated by the ladies. W. F. Bauer gets the credit for the first and O. B. Duncan for the second.



Billy B. Dad. H. C. M. Harry T.

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Billy L.

Lou K.

W. J. B.

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Frank R. Bryant.

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Niagara Lead & Battery Company.
D. M. Hepburn.
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Peerless Rubber Company.
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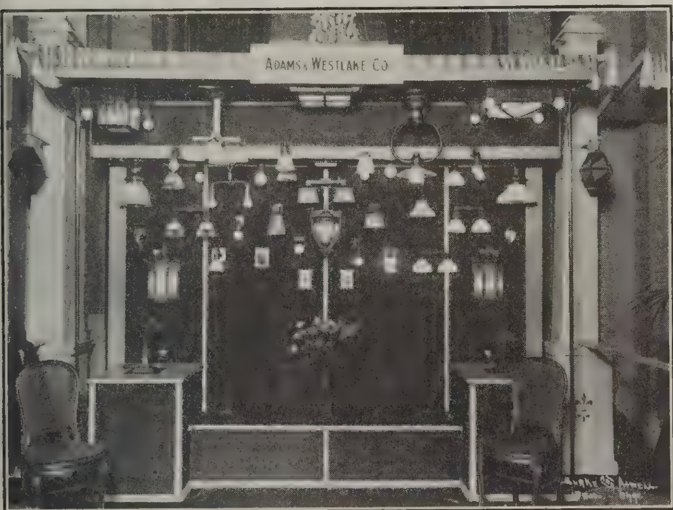
R. L. Kittle.
Pyle National Electric Headlight Company.
J. Will Johnson.
J. E. Kilker.
W. A. Vilas.
Railway Electrical Engineer.
Ralph Birchard.
Geo. W. Cravens.
Edward Wray.
Railway Equipment & Publication Company.
C. L. Dinsmore.
Republic Rubber Company.
J. H. Kuhns.
Wm. C. Robinson & Co.
Theo. Starr.
C. G. Swank.
Safety Car Heating & Lighting Company.
A. C. Moore.
Geo. E. Hulse.
J. G. Van Winkle.
R. W. Armstrong.
H. H. Halm.
C. E. Miller.
J. H. Rodger.
C. A. Pinyard.
E. S. Spinning.
Sangamo Electric Company.
J. H. Hodde.
Sprague Electric Works.
V. A. Swett.
Standard Underground Cable Company.
R. E. Green.
B. S. Stewart.
U. S. Light & Heating Company.
W. L. Bliss.
J. Allen Smith.
W. P. Hawley.
W. F. Bauer.
Alex. Russell.
Bertram Smith.
J. E. Widner.
Western Electric Company.
Geo. H. Porter.
Westinghouse Electric & Manufacturing Company.
B. F. Fisher, Jr.
A. J. Cole.
R. E. Geare.
F. H. Herzsch.
R. F. Moon.
H. C. Mode.
L. N. Pyle.
R. W. Soady.
Willard Storage Battery Company.
W. E. Ballantine.
R. Norberg.
T. A. Willard.

Exhibits at the Fourth Annual Convention of the Association of Electrical Engineers

Hotel La Salle, Chicago, Nov. 6-10, 1911

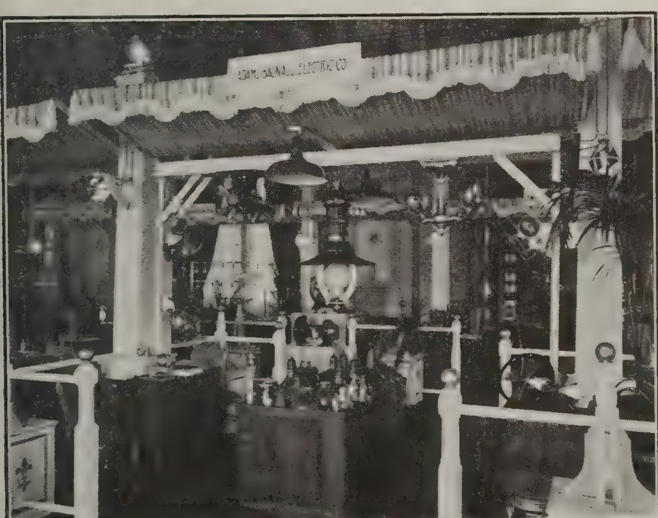
Adams & Westlake Company, Chicago, exhibited their elaborate line of electric car lighting fixtures, including box fixtures for the upper deck and half-deck, bracket fixtures of all kinds and berth lamps. Several applications of the Adlake shadeholder, a device designed especially for car lighting work and



Adams & Westlake.

entirely unaffected by jar and vibration, were shown. The exhibit was in charge of G. L. Walters, Sales Mgr., W. G. Howell and Mr. Anderson.

Adams-Bagnall Electric Company, Cleveland, O., made a strong exhibit of their three chief products for railway service—A-B regenerative flame lamps,



Adams-Bagnall Electric Co.

Jandus fans and ABolites. Several types of Jandus gyrofans were shown in operation. Industrial ABolites in many types and sizes excited much interest and received many favorable comments. The flame arc shown was big enough to light the whole exhibit hall. The exhibit was in charge of B. A. Stowe, Cleveland, chief engineer, J. G. Pomeroy, sales manager, C. W. Beach and V. N. Marker.

American Pulley Company, Philadelphia, Pa., called special attention to the new line of cork insert pulleys just recently placed on the market. It is claimed that with the cork surfaces belt slippage is impossible.

American Pulley Co.

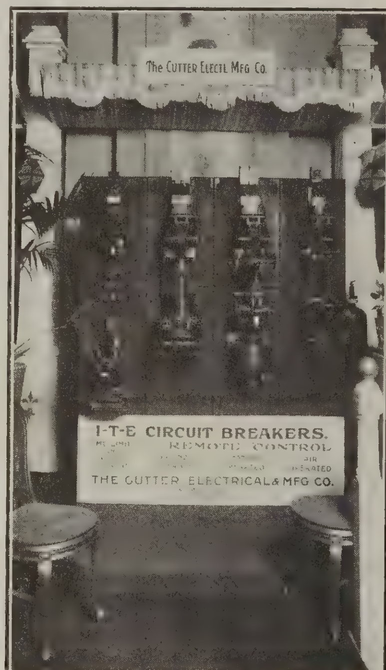
They also exhibited a pressed steel axle bushing in addition to their standard line of pressed steel axle pulleys. The company was represented by C. E. Brinley, Philadelphia, and John Forrest and C. P. Englehart, of the Chicago office.

Benjamin Electric Company, Chicago, made an exhibit of their steel reflectors and clusters for incandescent lighting of yards, shops and stations. The exhibit was in charge of H. E. Watson and G. B. Weber.

Central Electric Co.

Central Electric Company, Chicago, occupied space No. 1 with a comprehensive exhibit of the many lines

of electrical supplies which they handle. These included Okonite insulated wires and cables, Diehl fans, Columbia incandescent lamps, D & W fuses, Opalux reflectors, Okonite and Manson tape and several train lighting specialties manufactured by the Delta-Star Electric Company. A vacuum cleaner and other electric specialties were also shown. The exhibit was in charge of J. M. Lorenz and R. M. Baker of the Central Electric Company, L. G. Martin and W. J. Hovey of the Okonite Company, H. H. Smith of the Diehl Manufacturing Company, and C. D. Oldham of the Columbia Incandescent Lamp Company.



Cutter Co.

Consolidated Railway Electric Lighting & Equipment Company exhibited their regular "Axle Light" equipment and showed the new Type "L" regulator to many interested car lighting men. This regulator was brought out only about three months ago and was new to many at the convention. The exhibit was in charge of L. J. Kennedy, Chicago manager, A. O. Jackson and C. A. Latham.

Crouse-Hinds Company, Syracuse, N. Y., displayed their well-known line of condulets and other wiring accessories. Several large switches, panel boards and cabinets were also shown, and other specialties designed for railway service. The exhibit was in charge of F. F. Skeel, Chicago manager, C. Dubsky, E. G. Smith and Geo. A. Gray.

Cutter Company, Philadelphia, Pa., had an operating exhibit of circuit breakers which attracted much attention. The exhibit consisted of a four-panel switchboard on which were mounted one 1,000 ampere overload, direct acting, time limit circuit breaker; one 1,000 ampere overload and reverse current breaker for protection of storage batteries and generators operating in parallel; two 4,000 ampere remote control circuit breakers, non-closable on overload, one solenoid operated and the other motor operated; and a 2,000 ampere compressed air operated remote control breaker. In addition to these a Type W breaker for shop motor protection was shown. The exhibit was in charge of H. F. Darby, Jr., Chicago, and C. E. Wise, Detroit, Mich.

Edison Storage Battery Co.

Edison Storage Battery Company, Orange, N. J., showed Edison storage batteries for car lighting and railway signal service. The new car lighting cell with high tank was shown for the first time. A projecting electric sign utilized the floor space in front of the booth for advertising. The exhibit was in charge of H. G. Thompson, railway sales manager.

Electric Storage Battery Company, Philadelphia, Pa., exhibited their popular "Chloride," "Exide," "Tudor" and "Iron-Clad Exide" storage batteries. Sample plates removed from batteries in service for some years were shown as evidence of the durability and long life of the company's batteries. The representatives were H. E. Hunt, G. H. Atkin, R. I. Baird and H. M. Beck.

General Electric Company exhibited a great variety of electrical products for railway service including a Curtis train lighting steam turbine, Luminous and Flame arc lamps, motors, controllers, circuit breakers, transformers, fans, steam flow meters, instruments, soldering irons, toasters, stoves and chafing dishes, a mercury arc rectifier and last but not least, G. E. tungsten lamps for all kinds of lighting service. The exhibit was in charge of J. Scribner, A. I. Totten, J. L. Buchanan; and J. D. A. Cross, of the Chicago office, A. G. Jones, of San Francisco, and A. L. Broe, of Harrison, N. J.

General Electric Co.

Gould Coupler Company, New York, exhibited the Gould "Simplex System" of electric car lighting. They also distributed samples of the Gould "Simplex System" of smoking consisting of a long-stemmed cigar holder made in the shape of a pipe. One of these handy articles adorned the face of nearly every man at the convention, the demand for them being further stimulated by the fact the company dispensed a "Simplex" cigar with every holder. Gould Storage Batteries were shown. The exhibit was in charge of Geo. G. Milne, Sec., Dr. C. W. Gould, W. F. Bouche, Elec. Supt., and M. R. Shedd, Asst. Elec Supt, W. M. Lalor, Geo. R. Berger, R. N. Chamberlin, T. E. Booss and W. T. Sherman.

Heany Lamp Company, New York, exhibited Heany tungsten lamps for train lighting and other railway service. The exhibit was in charge of R. S. Carrick,

sales manager, of New York, and Ray P. Lee, western manager, of Chicago.

Holophane Company, Newark, Ohio, occupied two booths with a very elaborate exhibit of Holophane glassware for railway service. The specially designed reflectors that are the result of this company's study of the requirements of car lighting were exhibited as well as the standard Holophane lines in glass and steel. The methods by which scientific illumination is accomplished by the Holophane organization were explained by A. J. Sweet, Commercial Engineer and J. W. Foster, manager of the company's Chicago office.

Holophane Co.

Jefferson Glass Company, Follansbee, W. Va., exhibited many beautiful examples of "Luceo" reflectors for train and station lighting. Especially notable were some dull finish square shades having the appearance of transparent white marble. The exhibit was in charge of C. H. Blumenauer, sales manager.

Kerite Insulated Wire and Cable Company, New York, showed Kerite wires and cables in all sizes and for all purposes. Some illustrations of recent large railway installations were also shown. The company was represented by Azel Ames, of New York, and B. L. Winchell, Jr., and G. A. Graber, of the Chicago office.

Kerite Insulated Wire & Cable Co.

J. Lang Electric Company, Chicago, exhibited a complete line of switches and switchboards, large and small. O. B. Duncan and B. F. Fuller were on the job.

National Electric Lamp Association, Cleveland, O., showed "Mazda" lamps for all purposes. The drawn wire tungsten filament is used in these lamps. The exhibit was in charge of C. W. Bender, Commercial Engineer, and F. S. Marker, both of Cleveland.

New York Leather Belting Company, New York, showed their balata belts for axle lighting service. The new belt which goes under the trade name "Axonelat," manufactured at Easton, Pa., by the Victor-Balata and Textile Belting Company, was also shown. The representatives were W. H. Glatt, New York; Jos. Abt, Chicago, and Edward Vollrath, Easton, Pa.

National Electric Lamp Association.

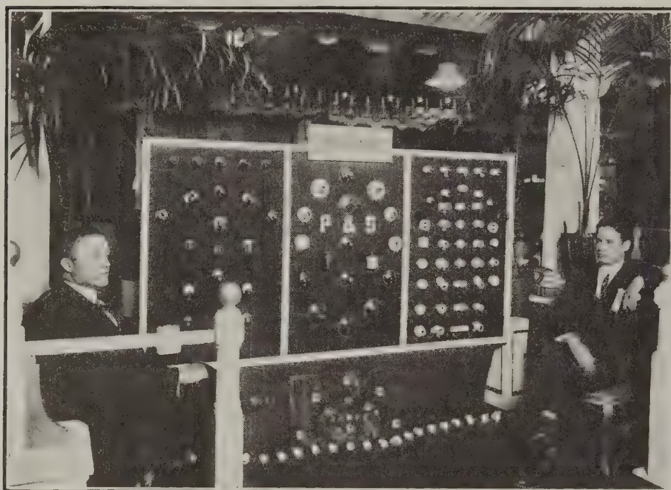
Niagara Lead & Battery Company, Niagara Falls, N. Y., exhibited "Salom" storage batteries for train lighting. These batteries are manufactured by an electrolytic process using Niagara Falls power. A small isolated lighting plant consisting of a gasoline engine, storage battery and switchboard was also shown in operation. The exhibit was in charge of D. M. Hepburn, general manager; J. A. Appleton, chief engineer; John J. Schayer, Chicago manager, and S. W. Sargent, railway sales agent.

Niagara Lead & Battery Co.

Nungesser Electric Battery Company, Cleveland, O., showed all sizes of primary batteries—"Acme Rapid Fire" batteries for ignition and "1900" batteries for

telephone train dispatching. A line of carbon electrodes and brushes was also shown. The exhibit was in charge of H. S. Green and Glenn A. Briggs.

Oneida Steel Pulley Company, Oneida, N. Y., exhibited their "Keystone" railroad pulleys, "Oneida" railroad pulleys and "Oneida" corrugated bushings for axle pulleys. A special ratchet wrench was also



Pass & Seymour Co.

shown. The company was represented by E. T. Shepard, secretary and N. G. Stark, assistant manager, both of Oneida, N. Y.

Pass & Seymour, Solvay, N. Y., and Chicago, exhibited their large line of porcelain and moulded insulation sockets and showed for the first time their lock socket which locks the lamp by pressing a small pin into the base of the lamp. This should prove of great value in reducing loss of lamps by theft. The

Safety Car Heating and Lighting Co.

company was represented by Victor R. Despard, Frank T. Haffner and Frank Driscoll.

Pyle National Electric Headlight Company, Chicago, had an operating exhibit of their electric headlight equipment, the generator acting as a motor to drive the turbine element. J. Will Johnson, J. E. Kilker and W. A. Vilas represented the company.

Pocket List of Railway Officials was represented by C. L. Dinsmore.

Safety Car Heating & Lighting Company, New York, had an operating exhibit showing the working of the "Safety" axle lighting equipment. The exhibit included a standard type generator, regulator, lamp regulator and switchboard panel. The new waste-packed oiler for the armature shaft was shown, as was also a complete model showing a "Safety" equipment installed on a regulation truck. "Safety" shade holders, "Opalite" shades and various car lighting fixtures were also included in the exhibit. The electric ignition for Pintsch gas lighting, consisting of a small magneto to throw a spark across the mantle,

United States Light & Heating Co.

excited favorable comment. The exhibit was in charge of A. C. Moore, general manager; J. G. Van Winkle, Chicago manager; R. C. Shall, vice-president; Geo. E. Hulse, chief engineer; R. W. Armstrong, electrical engineer; J. H. Rodger, C. A. Pinyard, W. G. Hermsen, E. S. Spinning, and H. H. Halm.

United States Light & Heating Company, New York, showed one of their standard Type "0-3" generators sectioned to allow inspection of the lead connections, ring chain oiler, reversible brush gear and all internal

Westinghouse Electric & Mfg. Co.

construction. Two regulating panels and a lamp regulator were exhibited. The "Type K" relay, shown for the first time, consists of a solenoid plunger acting directly on a carbon pile in series with the solenoid of the lamp voltage regulator. Its function is that of a multiplier making the regulator sensitive to very slight changes in voltage. The stop charge relay, Type "F-2" was also shown, as were "National" storage batteries for car lighting service. The company was represented by J. Allen Smith, vice-president; W. L. Bliss, chief engineer; C. E. Mead, assist-

ant engineer; W. F. Bauer, Chicago manager; A. Russell, manager of publicity; C. C. Bradford, Bertram Smith, J. E. Sinclair, W. R. Hungerford, L. S. Cunny, W. P. Hawley, and J. E. Widner.

Sangamo Electric Company, Springfield, Ill., showed their ampere-hour meters with and without the duplex train and special contact features; also type "H" induction watt meters for station service. M. B. Southwick and Mr. Holley were in charge.

Western Electric Company exhibited Sunbeam incandescent lamps and "Western Electric" Telephones for train dispatching and "Interphone" service. The company was represented by Geo. H. Porter, railway sales manager, J. B. Wilmott and H. C. Olmstead.

Westinghouse Electric and Manufacturing Company showed Westinghouse "Wire-Type" tungsten lamps. A testing rack loaned by the Pennsylvania Railroad for making a shock test on lamps was kept in continuous operation to demonstrate the sturdiness

Western Electric Co.

of this type of lamp. The company was represented by B. F. Fisher, Bloomfield, N. J.; A. J. Cole, L. N. Pyle, A. N. Brown, R. F. Moon, H. P. Mode, R. E. Geare, and R. W. Soady.

Willard Storage Battery Company, Cleveland, O., exhibited Willard Storage batteries for train lighting service and the various parts including the moulded lead strap for connecting the plates. The luxurious settee provided by the management made this booth a favorite lounging place for all. The company was represented by R. Norberg, manager, Cleveland, Ohio; W. E. Ballantine, Chicago manager, L. Sears and R. H. Green.

ELECTRIC TRACTION IN AUSTRALIA.

The Royal Commission appointed last year by the Victorian Parliament to consider the development of the railway and tramway systems of Melburn has recently made its report. The principal recommendations of the commission are (1) to purchase the entire system of street railways now in operation; (2) the conversion of all cable cars to operate electrically; (3) the electrification of all suburban railways after expert advice has been taken as to the most suitable system to be adopted; and (4) the establishment of the great State power station constructed according to the best engineering practice, capable of generating all the power required for operating both city street and suburban railway service.

The commissioners estimate that 90,000 horse power will be required at the outset and they recommend that the Central power house, high tension transmission lines and converter stations be placed under the control of the railway commissioners.

With regard to the electrification of suburban railways report states that in June, 1908, Mr. C. H. Merz in his report to the government estimated the cost of this to be approximately $10,800,000. A reconsideration of the proposition has reduced the estimate by approximately $500,000 and it is recommended by the commission that the electrification of these lines be carried out. It is also recommended that leading railway officers of the Australian railways be instructed to visit Europe and America at an early date and after a thorough investigation to make a comprehensive report on the latest methods and developments in the electrification of railways.

FRENCH SINGLE-PHASE LOCOMOTIVE.

The following is a description of the new single-phase locomotive built for the French Southern Railway. There are three 500-hp. motors. For voltage regulation induction regulators are employed. The three 500-hp. main motors are compensated series machines. Besides the excitation winding the stator has two parallel-connected compensation windings which also serve as commutation windings. The normal speed is about three times synchronism. Near synchronism the motor is connected as a repulsion motor. Since the French Southern Railway required electric braking so as to recuperate energy, the two compensated repulsion motors which drive the Westinghouse air compressor and the ventilators are provided with a special winding which is displaced by 90 space degrees against the main winding. When running down hill the main motors are excited as shunt generators from this winding so that an emf. in time-quadrature with the excitation voltage and therefore almost exactly in time-phase with the network voltage is produced.—J. Perrot and R. van Cauwenberghe, Elek. Kraftbetr. u. Bahnen, Sept. 24.

METALLIC-FILAMENT LAMP.

A note on a recent British patent (1544, Oct. 26) of the W. C. Heræus Company and C. Trenzen. A process of sintering partly decarbonized metallic filaments consists in placing them in a tube of pure iridium, which is heated to a temperature between 1400 deg. and 1600 deg. C, by passing currents up to 1500 amp. through it in the presence of a reducing gas.—London Elec. Eng'ing, Nov. 2.

MOORE-TUBE LIGHTING INSTALLATION.

An illustrated description of a three-phase Moore-tube lighting installation in the lecture-room of the electrical laboratory of the Institute of Technology in Breslau in Germany. The tubes are arranged in star connection. The mean illumination of the lecture-room is 120.9 lux (hefner lumens per square meter) or about 10 ft.-candles. The illumination is very uniform, as may be seen from the fact that the ratio of the maximum lux to the minimum lux is 2.45. Such low values of this ratio are otherwise obtained only by purely indirect illumination. The specific consumption is 0.442 watt per lux per square meter, which agrees well with former measurements.—G. Hilpert, Elek. Zeit., Nov. 2.

Train Lighting Instruction Car on Pennsylvania

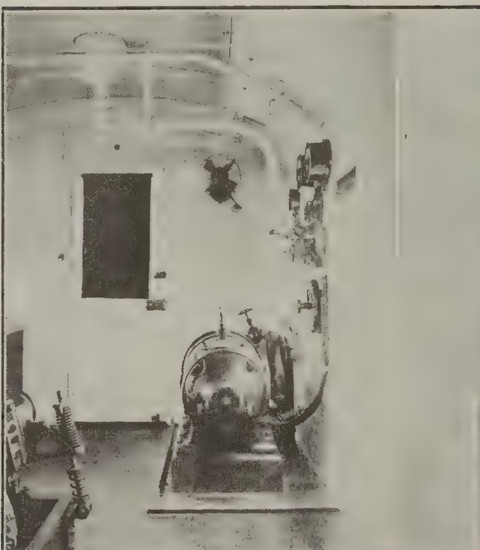
Continuing its policy of instructing employes in their several lines of duty, the Pennsylvania Railroad Company has just placed in service a "Train Lighting Instruction Car." The Pennsylvania Railroad has at this time no less than eight distinct axle device systems, in addition to the large number of straight storage equipments, and the Instruction Car seems to offer the most efficient means of furnishing uniform instructions to yard electricians. The present intention is that the car will be sent to the different points at which electrical forces are maintained and the men at such points will be given lectures and demonstrations on the operation and maintenance of the various equipments. For this purpose a car was selected and has been remodeled to suit the requirements.

The apparatus installed consists of a 32-cell storage battery, a 15 K. W. Curtis turbo-generator, a variable speed motor with necessary controlling apparatus for driving the axle devices, and the following axle generators with their regulating equipments:—Newbold, Moskowitz, Bliss, Consolidated, Safety and Gould. One end of the car has been partitioned off and equipped as an office and sleeping quarters for the instructor.

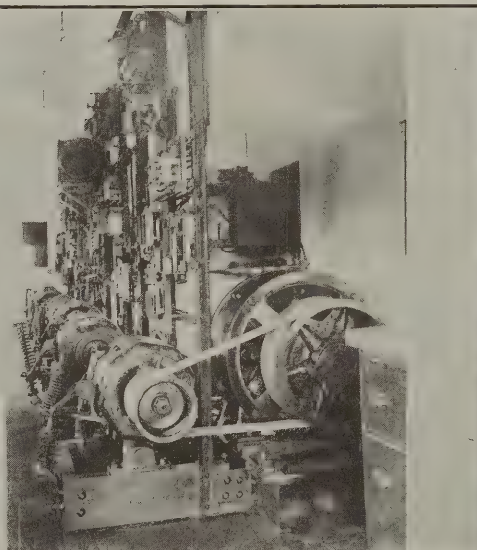
The storage battery is placed within the car in order that the cells may be used in demonstrating as well as for lighting the car; the usual battery boxes under the car are omitted.

The accompanying illustration shows the cells in their compartments, the latter being lined with sheet lead and arranged with ventilators through the car roof to conduct away the gases and fumes given off when the batteries are on charge. On the same plate is shown the main switchboard which controls the batteries, the straight storage apparatus, and a blue line to which the axle generators are connected.

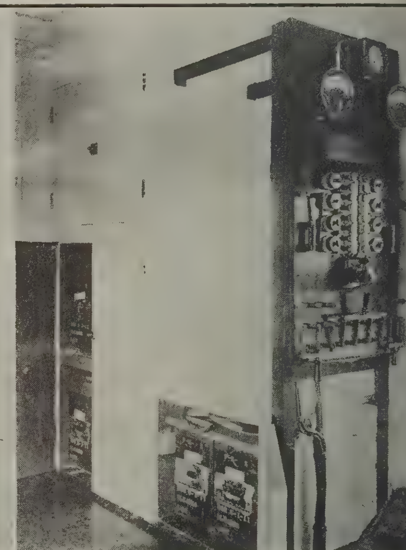
Another illustration shows the 15 k. w. turbo-generator set, as formerly used on all Pennsylvania Limited trains. In this case the usual switching devices are replaced by two single pole automatic circuit breakers, giving both overload and underload protection to the machine. The field rheostat and meters are seen mounted on the side of the car. Connections are such that the turbo-generator can be used for driving the motor, charging the batteries, and lighting the car, though under ordinary conditions the motor will be driven from yard power lines.



15 Kw. Turbine Set



Motor Drive and Axle Sets.



Battery Compartment.

On account of the limited space it was impossible to photograph the entire line of axle generators, consequently these were "taken" in pairs as shown. The generators are mounted on rocker shafts and are equipped with springs for regulating the belt tension as is done in actual service. Immediately back of each machine is an angle-iron framework on which is mounted the corresponding regulating apparatus, the equipment in each case being identical with that installed on passenger cars.

Instruction Car.

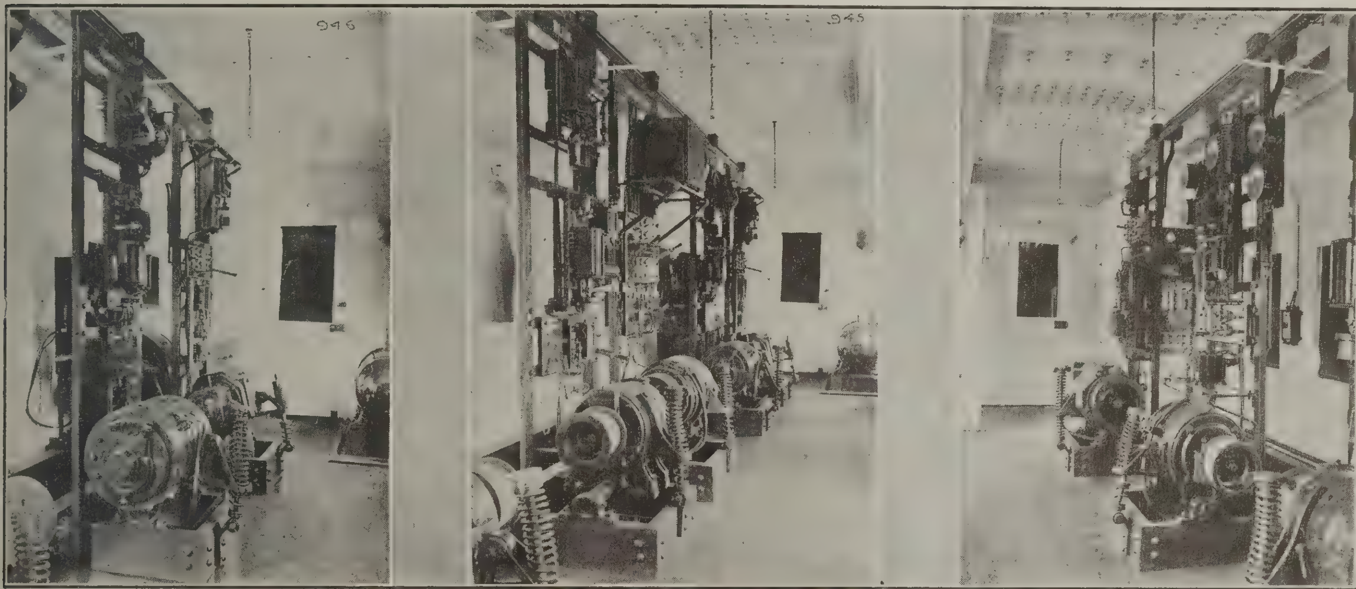
Each generator is connected through suitable switching devices to the lamp load and batteries, enabling the operator to demonstrate the apparatus under all conditions of load. The lamps used for this are banked in porcelain receptacles on the ceiling of the car.

The driving motor is shown belted to one of the axle devices. This motor is of the interpole type, and is mounted on an iron framework equipped with rollers, which enable the operator to move the motor

equipment along an I-beam track for belting up to any one of the six generators. The control panel for this machine is secured to the movable framework and moves with the motor. The rear of this panel showing the motor starting rheostat is shown in the photograph of the driving motor. The panel is equipped with two single-pole cut-in switches, double-pole reversing switch, circuit breaker and enclosed carbon pile used as a field rheostat. By a combined fuse and switch receptacle the motor is connected to the power circuit, there being several such receptacles spaced at suitable intervals along the side of the car.

One end of the car is used for the operator's office. This room also contains a folding couch, upper berth, clothes closet and toilet, the finish throughout being white enamel.

With the Instruction Car in operation it is intended that all employes whose duties have to do with the car lighting shall be instructed in the care and operation of the various equipments, with the two-fold object of educating those interested and securing uniformity in their work.



Interior of Construction Car Showing the Various Axle Lighting Equipments.

SHOP SECTION
EDITED BY
GEO. W. CRAVENS

Shop Series 8—Southern Pacific Shops at Sacramento

The Sacramento shops of the Southern Pacific Co. are supplied with electric power purchased outside and transformed and distributed through a substation located on the shop grounds. The substation building is 25 ft. x 60 ft. in size and contains apparatus totalling 2,000 k. w. in capacity, there being both three-phase alternating current at 440 volts and continuous current at 500 volts used in the shops. The amount of power used totals 1,200 k. w., of which 900 k. w. is for power and 300 k. w. for lights, although the total connected load is approximately 2,000 k. w. Distribution is done on both overhead and underground lines, depending upon conditions.

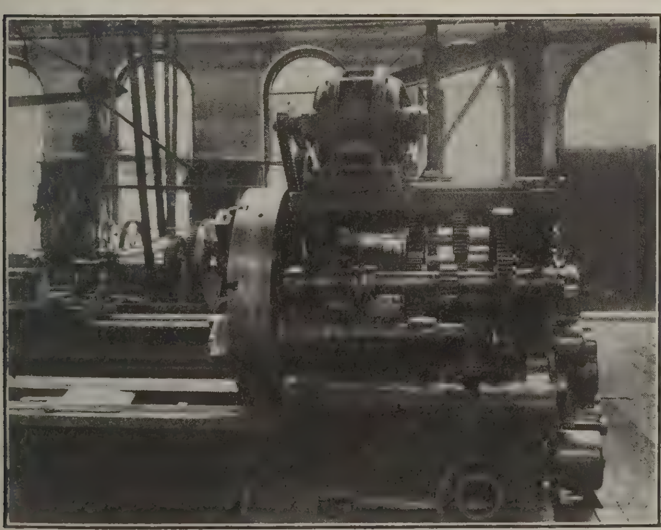


Fig. 1—A Good Example of Individual Drive.

The locomotive shop occupies a building 180 ft. wide by 575 ft. long and contains 25 pits extending crosswise of the shop. This building is divided into two general sections, one for locomotive erection and the other containing the machine shop. There are two jib cranes of 10 tons capacity each, one bridge crane of 20 tons and one of 120 tons capacity here, all operated by 500 volt d. c. motors. The jib cranes may be moved from place to place as required.

The tools in this shop are arranged so the small ones are grouped with large motors and the large ones have single motors, there being 100 motors total. Of these, 28 drive groups of tools and 72 are for individual drives. They are all 3 phase a. c. motors and range from ¾ h. p. to 150 h. p. in size. The lighting of this shop is noteworthy, there being an enclosed

arc lamp mounted on a swinging bracket on each steel column along the wall of the erecting section and others scattered about the machine shop section. There are 85 of these, total shown in Fig. 2, in addition to numerous incandescent drop lights.

The car shops are well equipped with motor driven tools, the usual assortment of blowers, bolt headers, nut tappers, hammers, punches, shears, etc., being in use. They are driven by individual 3-phase motors ranging from 2 to 50 h. p. in size. Two transfer tables are provided, each equipped with a 25 h. p. 500 volt d. c. motor. The freight car shop is lighted by 26 incandescent lamps and the passenger car shop by 14 arc lamps and 100 incandescents.

The Planing Mill building is 90 ft. wide by 230 ft. long and equipped a large number of wood working machines arranged in groups for motor drive. There are five large motors here, one of 50 h. p., three of 75 h. p. and one of 150 h. p. capacity, all 3-phase. One of the 75 h. p. motors drives the large fan,, and the other four motors each drive a shaft running cross-

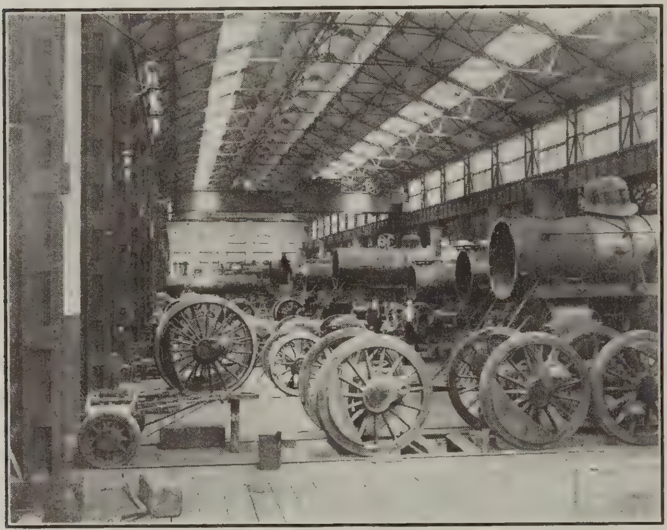


Fig. 2—Erecting Section of Locomotive Shop.

wise of the shop for driving the groups of machines. This shop is lighted by 15 arc and 15 incandescent lamps.

The Round House contains 29 stalls and is of the usual type, the turntable being driven by a 20 h. p. 500 volt d. c. motor. The yards and miscellaneous buildings are well lighted, there being 190 arc lamps and 2,010 incandescent lamps distributed there. No Cooper-Hewitt mercury vapor lamps are in use here, this being one of the few shops without them. The complete list of motors and lights in these shops follows:

TABLE I.
DISTRIBUTION OF POWER.

	Lights		Motors					
			Machines.		Groups.		Cranes, etc.	
Departments.	Incandescent.	Arc.	No.	H.P.	No.	H.P.	No.	H.P.
Sub-station	5	..	..	..	..	..	..	..
Locomotive shop	16	85	72	560	28	225	4	300
Freight car shop	26	..	..	..	..	..	2	50
Passenger car shop	100	14	24	395	..	..	..	..
Paint shop.....	150	..	..	..	..	..	..	..
Blacksmith shop	32	24	..	..	..	..	..	..
Planing mill....	15	15	..	..	5	275	..	..
Store houses....	201	..	..	..	..	..	..	..
Miscellaneous ..	1,626	165	..	..	..	..	1	20
Totals	2,171	303	96	955	33	500	7	370

The Fruitvale Power Plant, S. P. Co.

No description of the Southern Pacific Co.'s electrical equipment, however incomplete, should be given without some reference to the new power plant recently completed at Fruitvale, California. It is the intention of the Southern Pacific Co. to eventually electrify all of the lines on both sides of San Francisco Bay, and this plant is the first step in that direction.

This power station is designed to hold four 5,000

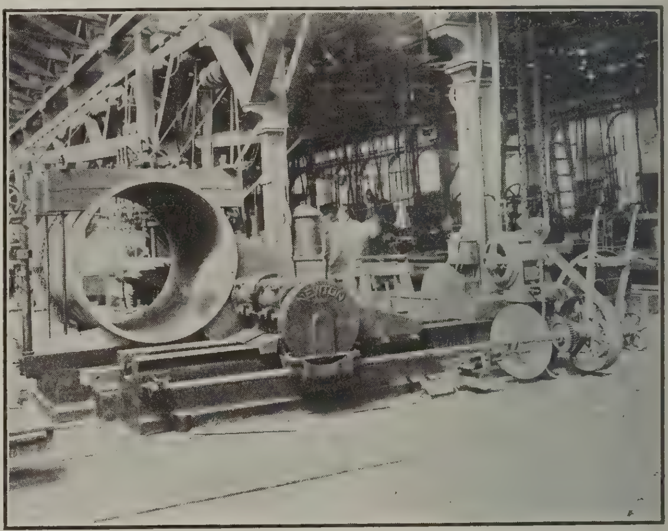


Fig. 3—Motor Driven Cold Saw.

k. w. turbo-generator units, of which two are now installed. Tests show them to be capable of delivering 7,500 k. w. each at the temperature rise guaranteed, so these two will deliver 15,000 k. w. continuously if necessary. These are Westinghouse units, the turbines being of the double flow type and guaranteed to deliver 5,000 k. w. at 15.9 lbs. of steam per k. w. Tests show them to do this with 15.8 lbs. They are also

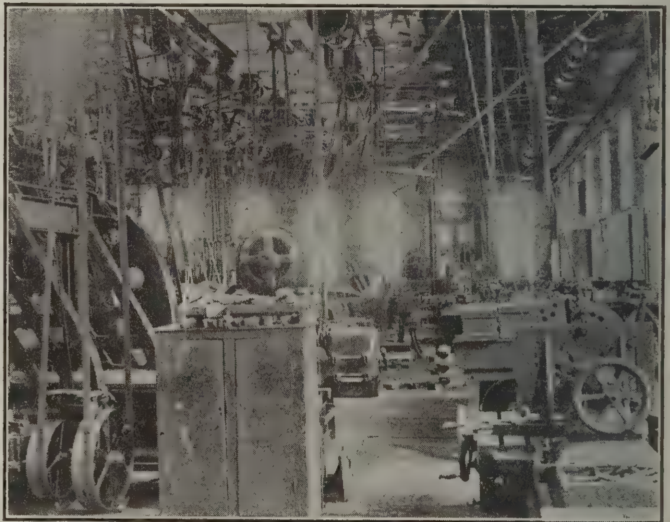


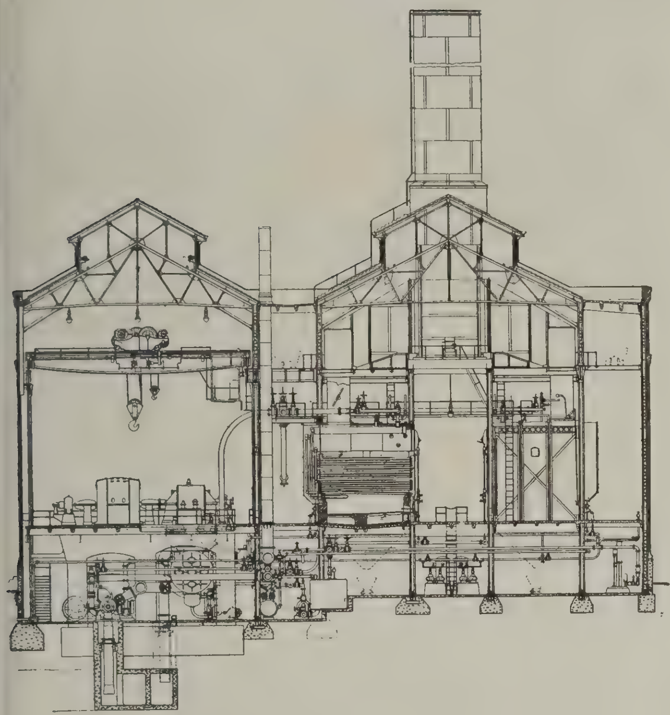
Fig. 4—Typical Group Drive in Locomotive Machine Shops.

guaranteed to deliver 7,500 k. w. on 17.5 lbs. per k. w. and actually did so on 15 lbs. per k. w.

These turbo-generators are rated at 5,000 k. w. a. at 40°C. rise but showed only 25.5°C. in armature windings, 34°C. in field windings and 34.2°C. in armatures. They are star connected for 13,200 volts, 3-phase, 25 cycles and have the neutral taps brought out for grounding. An iron grid rheostat of 13 ohms resistance is used as the neutral resistance, and it is capable of dissipating 6,000 k. w. for 30 seconds without injurious heating. This will limit the current to

about 600 amperes in case of a dead ground on one phase of a feeder, and is enough to operate the automatic circuit breakers on the feeder.

Most of the 13,200 volt wiring is run in fibre conduit



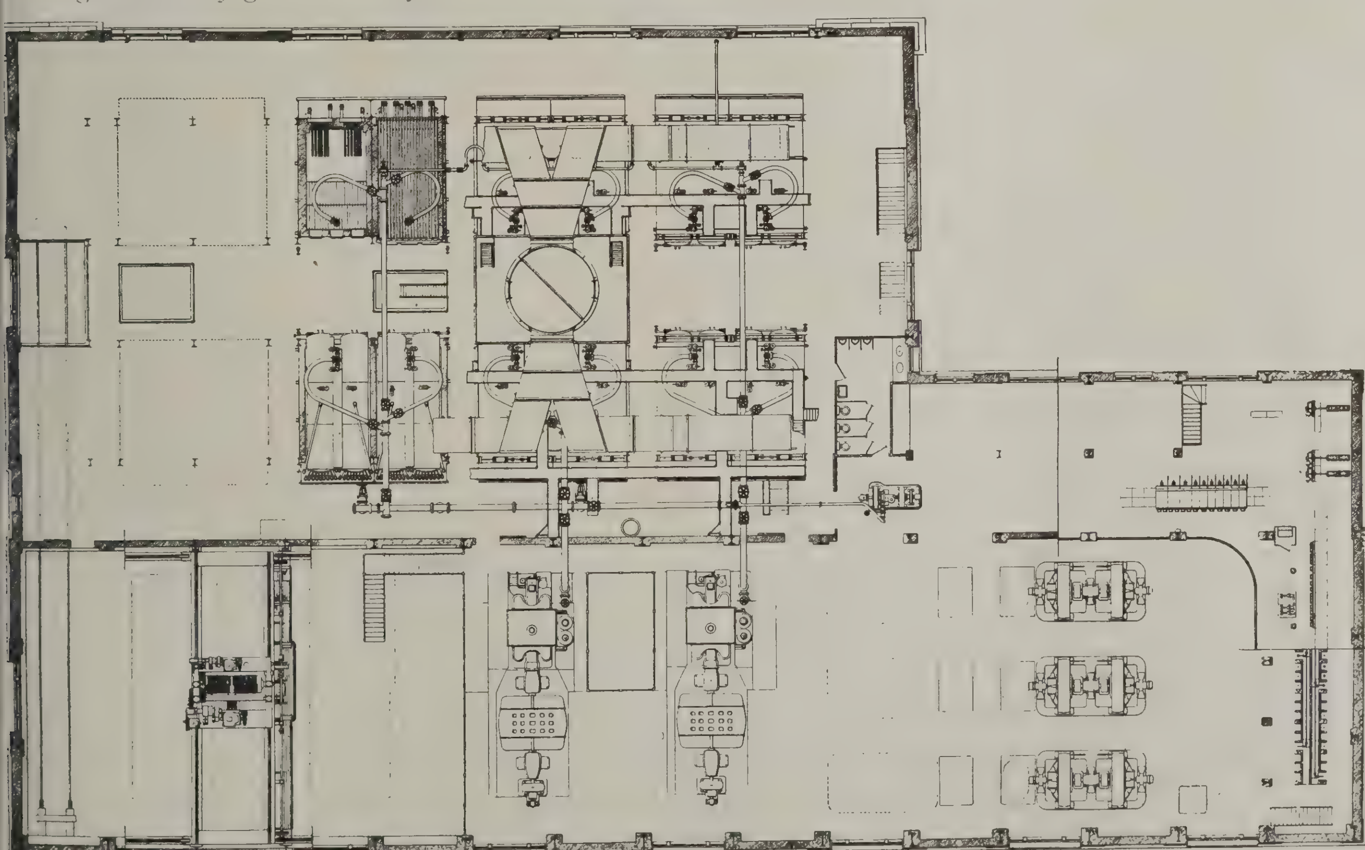
embedded in concrete, No. 4-0 single conductor cable with lead covered 14-32 varnished cambric insulation for generator and outgoing feeder leads. There are two sets of 13,200 volt busses and the switches are so arranged that any generator may be thrown on either bus. All of the 13,200 volt oil switches and busses are enclosed in concrete structures.

Each generator has an exciter mounted on an extension of the armature shaft, these being of 125 k. w. capacity at 250 volts and each one large enough for two generators even when overloaded. In addition to these there is a 125 k. w. General Electric turbo-generator exciter and a 136-cell storage battery of 280 amperes capacity for one hour. It is charged from either of the 250 volt busses through a motor driven 90-volt shunt booster. There are 16 end-cells with an electrically operated switch.

Sub-Station.

Located in an extension to the main turbine room is a local substation consisting of three General Electric 1,500 k. w. 1,200 volt rotary converters with transformers with space for three more sets. Each unit consists of two 750 k. w. 600 volt rotaries connected permanently in series on the d. c. side and mounted on a common base casting. Power is supplied by one General Electric Co. 1,500 k. w. three-phase to six-phase transformer with double secondary windings. These transformers are of the water-cooled oil immersed type, stepping down from 13,200 volts to 440 volts, and are located in a fire proof room in the basement with provision for removal through trap doors above. Each transformer is equipped with signalling apparatus to indicate when either oil or water stops flowing or if the temperature reaches 55°C.

Four 13,200 volt feeders run to other substations from the main station. Two of these run north through Oakland to the West Oakland substation and the other two run south through Alameda to the same substation. The north feeders run part way in conduits and part way overhead, while the south feeders run underground, over head and through submarine cables at various places. Provision has also been



Plan of Fruitvale Power Station.

made at one end of the main power house for a future high-tension transformer house.

The switchboards for both the main station and the local substation are located on a gallery at one end of the turbine room. The generating station board is in three sections, benchboard, generator and feeder panels, and the exciter and auxiliary d. c. panels. All of the speed-changing devices and generator-rheostats are motor-operated from the bench board section.

The 1,200-volt substation board is installed near but at a right angle to the main switchboard. This is of the double panel construction, with the front and rear panels 4 ft. apart, and all circuit breakers and oil switches of the hand-operated remote-control type. The switch operating levers and instruments are on the front row of panels and the circuit breakers and switches are on the rear panels. The 1,200 volt busses are in a fireproof compartment above the switchboard.

Steam for the turbines, etc., is obtained from 12 Parker type steam generators with oil fuel. Each of these boilers developes 650 h. p. and tests showed an equivalent evaporation from and at 212°F. of nearly 16 lbs. of water per lb. of oil burned.

The writer desires to extend his thanks to Mr. H. J. Small, Gen. Supt. M. P. of the Southern Pacific Co. for his kindness in sending the information given regarding the equipment of the Sacramento shops.

MECHANICAL REFRIGERATION OF TRAINS.

About the time that the first electric lighted trains were put in service in this country, there was considerable experimenting done with a view to developing a system of Mechanical Refrigeration which should take the place of icing. Although a great deal of time and money was spent, no system sufficiently economical in operation to be considered practical was developed. There were several systems that would work all right, but either the first cost was too high or they required too much supervision or they were not reliable.

In the last ten years, however, there has been a tremendous growth in the freight traffic in the perishable foods—fruits and fresh vegetables. On this account it is possible that a system which was an unwarranted expense ten years ago, might be a good investment today.

The problem of providing mechanical refrigeration is so similar to that of providing electric lighting, that some account of what has been done in that direction may be of interest.

In Russia they are using a head-end system and in France an axle-driven system in which the current from an axle generator is used to operate an ammonia compressor which cools a circulating brine.

The Russian system (Fig. 1) is described as follows:

A train of insulated cars was made up, with a special car in the middle, in which a complete refrigerating plant was carried. The plant was on the compression system, sulphurous acid being the refrigerant. The whole arrangement was very compact. The evaporator tank, which also carried the brine by which the cooling was carried on, was placed directly below the compressor. The condenser was fixed behind the buffer boards along the car, and power for driving the compressor was provided by a gasolene motor. A tank of cooling water was carried by the cars. The arrangement would be: the sulphurous acid compressor would compress the gas, as described above; it would be condensed into liquid, largely by the action of the air current, created by the movement of the car, the liquid refrigerant would pass into the evaporating coils in the brine tank, and the cooled brine was delivered to all the cars through flexible pipes connecting the refrigerating car with the adjoining cars, and each car with the next. In each car was a grid of brine pipes,

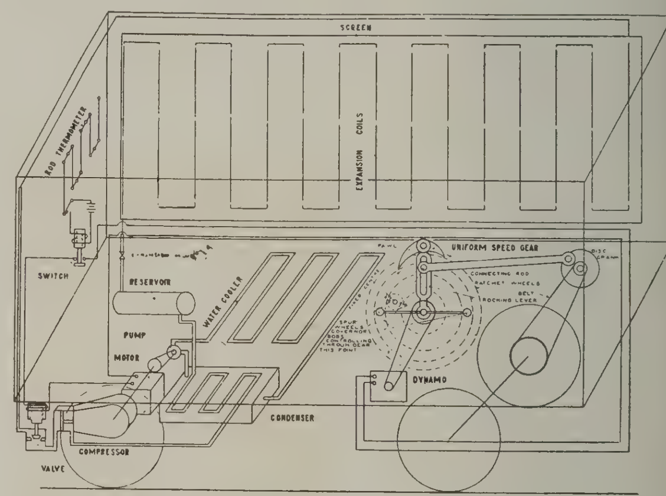


Diagram Showing Location of Apparatus.

and the brine was kept circulating throughout the train.

In addition, a current of cold air was provided throughout the train by means of fans driven by electricity, and circulating air through wooden ducts provided for the purpose. The engine which drove the compressor also drove a small dynamo for furnishing light and the power for the fans. In the Russian refrigerator cars steam is also provided in connection with the engine, because, as is well known, the climate in Siberia ranges between very hot in the small period of summer and very cold during the rest of the year. The refrigerator train has to transport the product at all times of the year, and to be always ready.

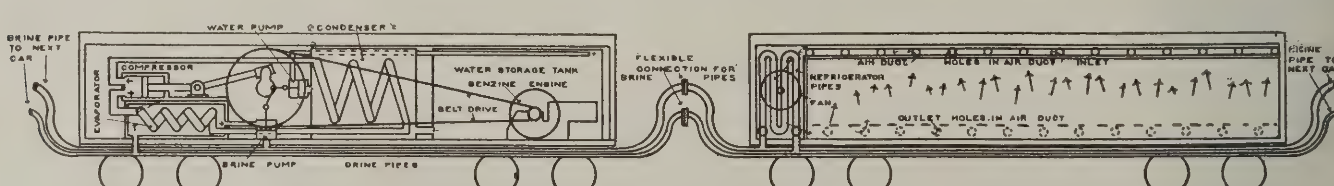


Fig. 1—Electro-Mechanical Refrigeration System in Use on Russian Railways.

Another car that was arranged for Russia was built like a Pullman car, and insulated with compressed turf, charcoal and cork. It was cooled by means of a carbonic acid compression plant, and steam was also provided for cold weather. One-sixth of the length of the car was occupied by the refrigerating plant, the remaining five-sixths being for the produce. It was designed to carry 25 tons of meat.

A car fitted up by the Aerothermic Car Company of France was arranged as follows: There was a compressor driven by a belt from the car axle, also the usual condenser and expansion coils. The condenser

is arranged in duplicate, the pipes being placed in two water tanks, located at either end of the car. The gas passes alternately through each condenser in turn. The cooling water for the condenser passed over the cold end of the compressor, which it is claimed increases the efficiency of the apparatus. The cooling is by direct expansion, the car being insulated as already described. In a modification of this arrangement the compressor is driven by an electric motor, and the speed is controlled automatically by the requirement of the refrigerating plant.

RALPH BIRCHARD JOINS EDISON FORCES.

Ralph Birchard, who has been actively connected with the Railway Electrical Engineer since June, 1910, first as Associate Editor and later as Manager, has resigned his position to take one with the Edison Storage Battery Company of Orange, N. J. The exact nature of Mr. Birchard's new position has not been given out, but he will be in the sales department and have something to do with the advertising. The change is effective December 1, after which date Mr. Birchard will be located at Orange.


Ralph Birchard.

Mr. Birchard is a native of Nebraska, but a graduate of the University of Wisconsin, where he received a technical education. He has had considerable journalistic experience. His connection with the Railway Electrical Engineer has given him a wide acquaintance in the electrical field on the railways and a familiarity with the storage battery requirements of that field which will undoubtedly be of advantage to him in his new work.

Adams-Bagnall Changes:

Mr. J. G. Pomeroy, formerly Western Sales Manager of The Adams-Bagnall Electric Company, has been appointed Sales Manager of the Company with headquarters in Cleveland.

Mr. C. L. Eshleman has been appointed Publicity Manager with headquarters in Cleveland.

The company has opened a Boston office under the management of Mr. E. R. Bryant, formerly connected with the company's New York office.

The company will carry a stock of all its lines in Boston and hopes in this manner to render its New England trade an improved service.

A. C. INDUCTANCE REMOVED FROM TELEGRAPH

Since the introduction of alternating current railways the telegraph lines paralleling railway circuits have been greatly troubled by induced currents which caused the telegraph relays to chatter to such an extent as to render communication impossible.

A simple device, however, has recently been developed and successfully tried out which entirely eliminates trouble from this source. The details of this device are not yet ready for publication but they will be fully described in an early issue of the Railway Electrical Engineer.

ELECTRIC HEADLIGHT COMPANY CONSOLIDATION.

The Remy Electric Company, of Anderson, Ind., the world's largest builders of magneto ignition and lighting devices for all types of gas engines and gasoline motor driven vehicles, which recently absorbed the American Electric Headlight Company and now makes the American Electric Headlight for steam locomotives, has purchased outright all patents, designs, good will and manufacturing rights of the Peters Electric Headlight for steam locomotives.

The locomotive headlight departments of the R. G. Peters Company, of Grand Rapids, Mich., have been moved to Anderson and the Peters light will be owned, manufactured and sold by the Remy Company. New buildings will be erected at the Anderson plant to care for the increased production of the Peters lighting apparatus.

E. L. POLLOCK GOES WITH SAFETY COMPANY.

Mr. Edward L. Pollock, formerly Vice-President in Charge of Purchases of the Rock Island Lines has just become commercially associated with the Safety Car Heating and Lighting Company. Mr. Pollock will be located in the Chicago office of that company.

TEN DOLLARS REWARD.

Ten dollars reward is offered for the return of a garnet pendant lost by Mrs. K. R. Sternberg during the Convention of the Association of Railway Electrical Engineers, Nov. 6-10, at the La Salle Hotel. The pendant was a family heirloom and Mrs. Sternberg is very anxious to recover it. It should be sent to K. R. Sternberg, Dickinson Mfg. Co., Springfield, Mass.

TRAIN LIGHTING IN ENGLAND.

At an early meeting of the Institution of Civil Engineers of England Mr. Roger T. Smith, electrical engineer of the Great Western Railway of England will present a very interesting paper on the subject of "Electric Lighting of Railway Trains." This paper is a comprehensive treatise on the subject and should be of special value to our readers, as it gives an idea of the present train lighting practice in England.

As this paper has not yet been presented, we do not have permission to publish any part of it, but a complete abstract will be published in an early issue.

ELECTRIC STORAGE BATTERY CO. CONVENTION. LINES.

The Electric Storage Battery Co. of Philadelphia, held the sixth convention of its staff and sales department at the Bellevue-Stratford, Philadelphia, on November 6th, 7th, 8th, 9th and 10th.

The convention was attended by the managers and salesmen from its various sales offices in Philadelphia, New York, Chicago, Boston, Cleveland, St. Louis, Denver, Detroit, Atlanta and San Francisco. At the conclusion of the convention a company banquet was held at the Radnor Hunt Club.

Mr. J. M. Klingelsmith, formerly connected with the Lansden Company, of Newark, New Jersey, and lately in charge of the electric truck department of the Anderson Electric Car Company, of Chicago, has been appointed Western representative of the Edison Storage Battery Company with headquarters in the Peoples Gas & Coke Company Building, Chicago, Illinois.

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

INDIRECT ILLUMINATION OF CARS.

It is unfortunate that the dining cars of the new Santa Fe de-Luxe train described in another part of this issue were not provided with a properly designed system of indirect illumination, as this is the first public attempt at indirect illumination of railway cars. It is a big step in the right direction, and is worthy of our special attention.

As the car is finished in a rich dark mahogany its co-efficient of reflection is practically nil. The management says that it was not their intention to light the car entirely by the indirect system, but rather that the indirect fixtures were supplied simply to properly light up the ceiling of the car. There have been a number of beautiful diners recently put into service on other roads however, the ceilings of which are of a light cream color having an excellent co-efficient of reflection. We certainly regret that the first practical demonstration of indirect illumination of railway cars should be made in a car so poorly designed for that type of illumination.

The new cars built by the Pennsylvania Railroad Co. with the quarter deck eliminated which have an arched roof would, if properly decorated, be most admirably adapted to this type of illumination, and it is to be hoped that at least an experimental installation of indirect illumination in this type of car may be made at an early date.

Notice has just come to hand of a new private car on the Frisco line which has been equipped with indirect illumination and we shall publish a full description of this in the February issue.

CAR VENTILATION.

There is probably no other problem with which the passenger departments of the various railroads have been working with so little satisfactory result as the ventilation of dining and sleeping cars. The inefficiency of the old deck sash ventilator is well known and to increase its effectiveness, there have been developed numerous types of suction ventilators, which, while the car is in motion greatly increase the current of outflowing air.

These as far as they go are excellent, for they remove the foul vitiated air in the roof of the car en route. They are entirely inoperative, however, when the car lays at terminal points before making its run as is customary with a great many trains.

Another serious objection to this system is that while it provides excellently for the removal of air, it makes no provision whatsoever for the introduction of air to replace the air removed, it being assumed that there will be sufficient leakage through windows to balance the ventilator output. Actual operation of these ventilators, however, especially on diners, shows that the system is wrong, for much of the incoming air comes from dusty vestibules and foul toilets.

The most logical system of car ventilation is one in which both inlet and outlet are controlled, but one in which the intake of air is controlled and the outlet disregarded is far superior to the reverse situation which generally exists in most of the modern systems.

The new ventilation equipment of the Santa Fe de-Luxe train described in another part of this issue, is the first practical application of this principle in railway car ventilation. Air is taken directly through the roof of the car and passed through an air washer which entirely removes all dust and cinders and cools the air to a comfortable degree. This ventilating equipment is intended primarily for use on crossing the hot desert plains of New Mexico, and accordingly no heating provisions are made in connection with the system. This does not, however, in any way alter the ventilating feature of the equipment as an installation of steam heating coils could readily be made over which the washed air might be passed.

Numerous objections to the equipment described are at once evident, chief among which is the heating feature, but this installation is at least a hopeful indication for the future. And it is most devoutly hoped that there will ultimately result a proper ventilation of coaches and diners and an individual berth ventilating system for Pullman cars.

VARIABLE SPEED ALTERNATING-CURRENT MOTOR.

Practically the one objection counteracting the many advantages of the alternating-current motor over the direct-current type is its lack of speed adjustment which has been so highly developed in the direct-current type.

The paper by Mr. G. A. Maier, recently presented before the American Institute of Electrical Engineers, which is abstracted in this issue, throws some interesting light on this big problem. Mr. Maier gives a resume of all of the systems devised up to the present

time for varying speed of any alternating-current motor, whether theoretical or practical. It is the first comprehensive statement of the situation, so that as such, it should receive the careful consideration of all electrical men interested in motor operation.

ASSOCIATION NEWS.

The December meeting of the Executive Committee of the Association was held December 20th, 1911. Present, F. R. Frost, C. J. Causland, F. E. Hutchison, A. J. Farrelly, C. R. Gilman, E. W. Jansen, L. S. Billau, H. C. Melloy, J. Andreucetti. Twenty-five applications for membership were passed upon. It was decided to give more importance in future meetings to the matter of electrification of steam railroads than has been done in the past, and it was also decided to extend a personal invitation to certain railroad men prominent in the development and operation of electrified sections.

Chairman of the various Committees will be invited to attend the next meeting of the Executive Committee to receive instructions as to definite program to be followed out in their Committee work for the ensuing year.

Blanks conforming to the report of Committee on Accounts and Reports have been prepared and will be furnished to senior active members at an early date. It is especially requested that whenever any information as to cost of car lighting is supplied a foreign road it shall always be made to conform to the blanks as recommended by the committee.

Additional blanks will be gladly supplied on request by the RAILWAY ELECTRICAL ENGINEER.

CAR LIGHTING CLUB.

The December meeting of the Car Lighting Club was a joint meeting with the Chicago Section of the Illuminating Engineering Society, and Mr. C. W. Bender, Commercial Engineer of the National Electric Lamp Association, gave a talk on the "Drawn Wire Mazda Lamp." Mr. Bender's talk is given in another part of this issue, suffice to say here that Mr. Bender covered the subject in a clear and comprehensive manner, and in plain everyday English without the flourishes brought the rather difficult subject of the economics of Mazda lamp operation, down to a point where it could be readily understood by the layman.

In the discussion that followed, Mr. Gilman asked about the relative merits of the 30 volt and 60 volt drawn wire lamps for train lighting. Mr. Bender said, that as far as lamps were concerned, there was little to choose between them, but that 60 volts for head-end system was a more practical one. Either one, however, is to be preferred to the 110 volt system. The matter of theft of the tungsten lamps was considered and found to be the cause of a surprisingly large percentage of the necessary lamp renewals. This was an argument strongly in favor of the 30 and 60 volt systems, as one or two experiences of a thief placing a low voltage lamp on 110 volt circuit will soon convince him that there is something wrong and he will not be apt to repeat his thievery. With a 110 volt system, however, he would obtain an expensive lamp which would suit his purposes entirely.

Mr. A. J. Farrelly made an interesting announcement, that the Northwestern and the Northern Pacific Railroads have just decided to adopt the 60 volt system as a standard for train lighting. These two railroads are the last of the Harriman lines to change to the standard voltage, and this announcement is welcomed by all advocates of the standard system.

The next meeting of the Club will be held Wednesday evening, January 24th (note the change in date), and an old fashioned Car Lighting Club meeting is planned. Subject of the evening is to be "Troubles and How to Shoot 'Em." Mr. Geo. B. Colegrove and H. G. Myers will open the discussion and everybody is expected to come loaded with troubles.

At this meeting the annual election of officers for 1912 will be held.

SMOKE ABATEMENT AND ELECTRIFICATION.

The committee appointed last summer to make a thorough investigation of the problem of smoke abatement and electrificataion of railways terminating in Chicago made their first progress report last month. The work done by this committee is reviewed in an address by President Wheeler of the Chicago Association of Commerce at a recent dinner, the following of which is an abstract:

"Jointly with the analysis of smoke and its effect, inquiry is being instituted into the possibility of electrification. Already a survey has been made to ascertain the trackage which must be considered within the city, aggregating 600 miles of first and second main track and 1,700 miles of sidings, yards, etc. To this must be added 1,258 miles of track in the smoke zone, giving some conception of the magnitude of the problem, the cost and feasibility of which the committee has set itself to ascertain.

"This great survey has for its object a triple purpose: first, to ascertain by complete co-operation of all the railroad lines how many locomotives may be cut out of service within the city limits by an agreement for the joint use of motive power; second, how much through freight may be diverted around the city; third, cost and feasibility of electrification.

"Our investigation is of international interest, for nowhere does a parallel situation exist. Here may be studied scientifically, under the most favorable circumstances, an evil which has troubled the world for centuries. Here may be studied a railroad terminal proposition which for magnitude with respect to trackage and motive power is unequalled."

CAR LIGHTING CLUB CONTRIBUTIONS.

We are pleased to acknowledge receipt of numerous contributions toward the expenses of the Car Lighting Club for the year 1911-12 as follows:

Adams Bagnall Elec. Co.	$2.50
Adams & Westlake	5.00
Beattys, W. H., Jr.	1.00
Bender, C. W.	5.00
Central Elec. Co.	5.00
Consolidated Ry. Elec. St. & Equip. Co.	5.00
Delta Star Elec. Co.	5.00
Diehl Mfg. Co.	5.00
Edison Storage Battery Co.	5.00
Elec. Storage Battery Co.	5.00
Farrelly, A. J.	5.00
General Elec. Co.	5.00
Gilman, C. R.	3.00
Gould Coupler Co.	5.00
Hutchison, F. E.	3.00
Jansen, E. W.	3.00
Kerite Ins. Wire & Cable Co.	5.00
Macbeth Evans Glass Co.	5.00
Pyle Nat. Elec. Headlight Co.	5.00
Railway Electrical Engineer	5.00
Safety Car Htg. & Ltg. Co.	5.00
United States Light & Heating Co.	5.00
Western Elec. Co.	5.00
Westinghouse Elec. & Mfg. Co.	5.00
Willard Storage Battery Co.	5.00

Edward Wray, Secy.-Treas.

New Santa Fe De Luxe Special

The popularity of the fast excess fare trains between Chicago and New York, and the increasing growth of traffic between Chicago and Los Angeles has induced the Atchison, Topeka & Santa Fe Ry. Co., to place in service one of the finest trains ever run West of the Mississippi, the Santa Fe de Luxe special.

As this new train contains some special features in lighting and ventilation it becomes of great interest to all Car Lighting men, in fact, it may be said that it marks an epoch in the development of railway passenger service.

Fig. 1.—Interior of Diner Showing New Lighting Fixtures.

Although there have been some isolated cases of private cars being equipped with indirect illumination, and air washing equipment this train carries the first public application of the indirect system of illumination of railway cars, and we believe is the first attempt at an air washing system of ventilation. The dining car, however, is the only car of the train equipped for indirect lighting. It carries seven large bowl fixtures in the upper deck and a small table lamp over each of the ten tables in the car as shown in the accompanying illustration.

The upper deck fixture consists of a large inverted art glass bowl mounted in an ornamental cast brass frame supported from the ceiling by three solid rods. The usual chain support of this type of fixture when installed in auditoriums and offices is out of the question on account of the motion of the car. Inside the inverted art glass bowl is mounted a large Holophane reflector and three 15 watt lamps are placed on a special socket tripod support.

The car is decorated in rich dark mahogany which is very beautiful but does not conform in any way to the specifications of a good reflecting surface. It was not the intention of the designer, however, to light the car by indirect illumination, but rather to install an ornamental fixture to provide just enough illumination to light up the car ceiling and display a warm art glass color through the fixture itself.

For real illumination of the table, however, there is an individual table lamp placed on each of the ten tables. A 25 watt tungsten lamp is mounted in a beautiful fixture harmonizing with the main upper deck fixtures and like them, has a Holophane reflector and art glass for decorative effects.

In respect to the ventilation equipment this train is especially unique, and although there may be many points wherein the equipment can readily be improved, it marks a big step in the right direction.

The buffet and the dining car are each equipped with a Duntley air washer specially designed for railway service. Of the two, the air washer in the buffet car, which is mounted in the baggage compartment of that car, was the most accessible so a photograph of that is shown. The dining car air washer, however, is identical with this one and is installed in the vestibule.

The air washer is of special design although it embodies all of the principles of the standard Duntley air washer, and has a capacity of 90,000 cubic feet of air per hour, which, assuming 60 passengers, will provide a possible ventilation of 1,500 cubic feet of air per hour per passenger. This is more than ample.

The air is drawn through a hood vent in the quarter deck as shown in figure 2 "A" and goes directly into the air washer where all dust and cinders are removed. The

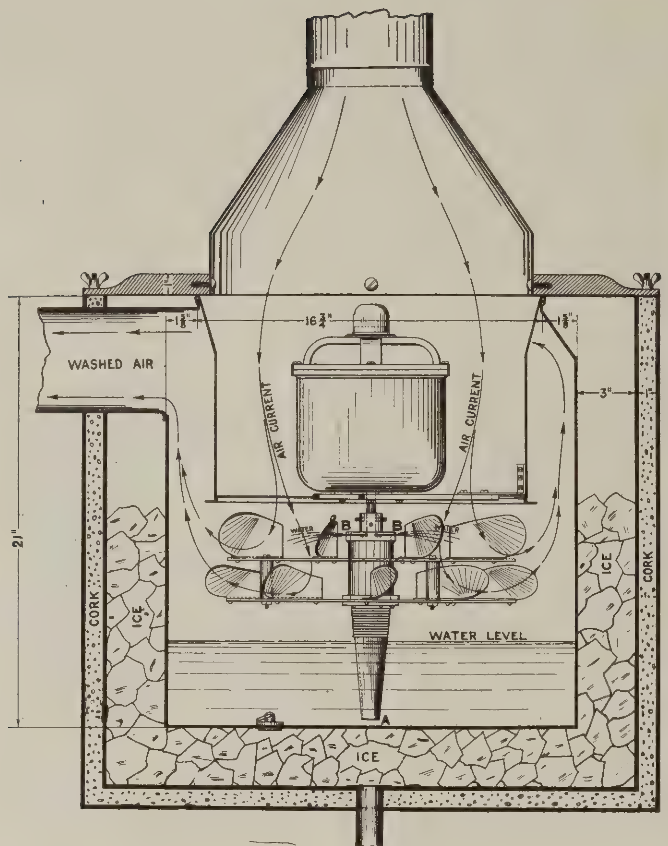


Fig. 2.—Section Through Washer.

entire washer is packed in ice so that the current of air in passing through the spray of ice water is not only thoroughly cleansed but is cooled very considerably. This cleansed and cooled air is then forced through ventilator duct "B," which is about 5 inches x 10 inches in section and leads to ventilators in the buffet car placed immediately below the quarter deck as shown in Fig. 3. There is no provision made for heating the air as received from the washer, it being the intention of the management to operate this system only in the summer

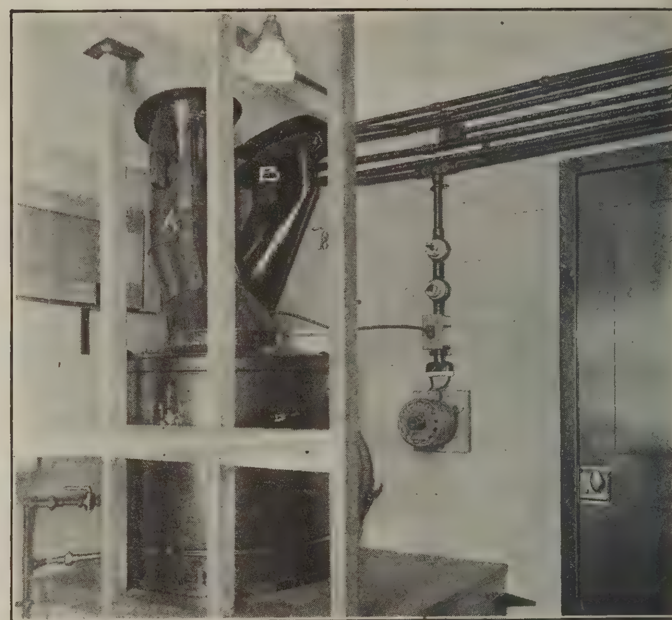


Fig. 3.—Air Washer.

time to provide some degree of comfort to the traveler in passing through the hot arid desert lands.

The detail construction of the air washer is best shown by Fig. 4. A 1-3 h. p. motor operating at 1,200 r. p. m. is mounted on a vertical spider supported in the center of the washer. It is direct connected to ventilator fan having a compound set of blades. A rheostat in the motor circuit is provided for starting up this fan, but this is hardly necessary, and in fact has seldom been used. As the motor speeds up water is drawn upward by

Fig. 4.—Interior of Buffet Car Showing Ventilators in Quarter Deck.

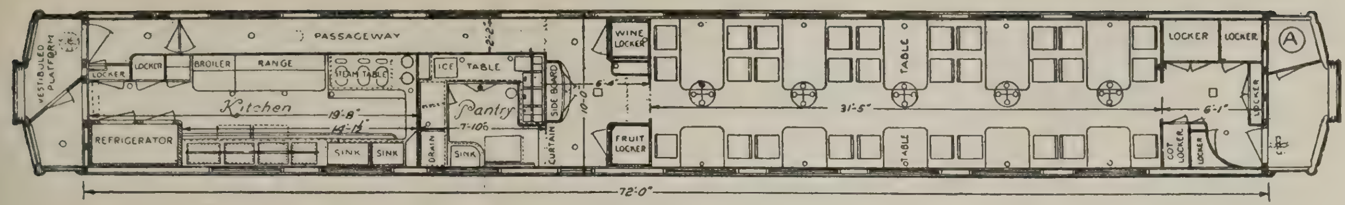


Fig. 5.—Floor Plan of Diner.

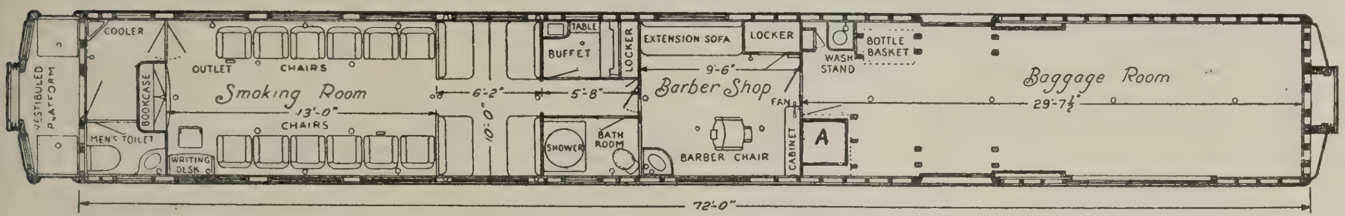


Fig. 6.—Floor Plan of Buffet Car.

centrifugal force over the slightly tapering surface on the inside of pipe "A." When this creeping of the water surface reaches the height of slot "B," it is thrown outward by centrifugal force in a very fine spray directly through the current of incoming air and cleanses the air of all cinders and dust. This spray of washing water is ultimately returned, with its collection of dust and dirt, to the bottom of the tank where the heavy matter at least is deposited in a sludge on the bottom. The entire washer is packed in ice as shown, and outside the ice chamber is a substantial layer of crushed cork which prevents excessive melting of ice in hot weather.

A drain plug is placed in the bottom of the air washer chamber which permits the collected mud and dirty water to pass into the ice chamber, which in turn is supplied with a drain cock for drawing off both ice and washer water when washer is cleaned and refilled.

On account of the evaporation of the washing water the temperature within the washer is lowered considerably so that if the equipment is operated when the air temperature is even as low as 35 degrees, ice will be formed in such quantities as to stop the motor. This can readily be cared for, however, where it is desired to operate this equipment in cold weather by a few steam coils in the ice chamber. For purposes of heating the air supplied, however, the heater must be so placed that the air will pass through it after it has passed through the washer. This will materially reduce the humidity of the air as delivered at the ventilators which is a desirable feature.

Mazda Drawn Wire Filament Lamps

Their Use and Economics

By C. W. BENDER

In the consideration of the "Mazda" lamp it seems hardly necessary to review its history as this has been treated in detail many times by worthy authorities. On the other hand, it is the intent of this article to view the subject from two standpoints, namely, the metalography and the most economical efficiency. Although these two subjects may seem widely separated they are in reality closely associated.

There are four methods of producing pressed filaments for "Mazda" lamps, of which the Auer or paste process has been most generally used in this country. The method of procedure is to obtain tungstic acid, which is a fine yellow powder, from some one of the tungsten ores, as Wolframite or Scheelite. The acid is converted into oxide and further reduced by heating in an atmosphere of hydrogen to form the pure metal which is finally obtained as a dark grey powder. This powder, together with a binder, is mixed into a plastic state and squirted through a die. The product is then heated in an inert gas to drive off the volatile constituents of the binding material.

It has been found that a filament made according to this process is pliable when hot and can be shaped into any desired form. When cold, however, it is comparatively brittle, which results in more or less breakage in the lamps unless considerable care be taken in handling. Furthermore, filaments made by this process are not suitable for lamps intended to be used in such service as street railway cars, automobiles, marine service, or other service where extraordinary vibration is present. Therefore, the leading lamp manufacturers have expended considerable time and money endavoring to perfect a drawn tungsten wire that would be suitable for filaments in lamps used for such service.

The "Mazda" lamps as now manufactured by several of the leading lamp manufacturers are furnished exclusively with a drawn wire tungsten filament. The tungsten metal after being subjected to a certain preliminary treatment is drawn through diamond dies, each drawing reducing the size until the wire is of the proper diameter for the filament desired. This wire product as now made is perfectly pliable ductile wire, which has a tensile strength of several hundred thousand pounds per square inch. The following table shows the results of tensile strength tests on some wire taken at random from the product.

Size.	Diameter.	Tensile Strength, Lbs. per Sq. In.
100 watt	0.00290	451,000
60 watt	0.00207	499,000
40 watt	0.00153	547,000
25 watt	0.00118	737,000

It should be understood that, although the drawn

tungsten wire as now used in the "Mazda" lamp has a very high initial strength, the metal does not retain this enormous strength after burning. Nevertheless, although the drawn wire filament loses con-

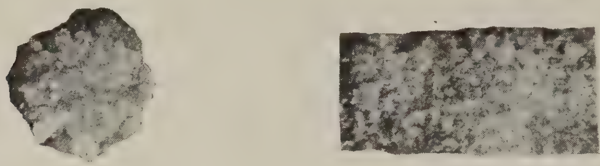


Fig. 1.

siderable of its strength, it is stronger at the end of the lamp life than the pressed filament is after a few hours' burning.

High tensile strength, however, is not the sole requisite for a lamp filament. It is equally important that the filament be capable of withstanding a certain degree of bending stress. In this respect the strength of the drawn wire filament also exceeds that of the squirted filament.

It seems probable from results of recent tests that the drawn wire filament has a fibrous structure. The squirted filament, on the other hand, although fibrous

Fig. 2.

to a certain extent, seems to possess to a marked degree a granular structure. This structural difference is no doubt a governing factor in the strength of the two quantities.

The examination of the pressed and drawn wire filaments under the microscope reveals an interesting change in the structure of the filaments which may be best shown by microphotographs of the cross-sectional fracture. It is rather difficult to get micrographs which will show distinctly this structure, due to the fact that all parts of the slightly irregular surface cannot be brought into sharp focus.

The following micrographs are illustrative of the difference in structure of the pasted and drawn wire filaments. In every figure two sections are shown, namely, a cross section and a longitudinal section.

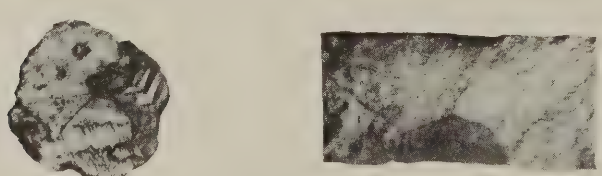


Fig. 3.

Figs. 1 to 3, inclusive, typify pasted filaments. Fig. 1 represents the filament from a new lamp. Fig. 2 is the filament at the end of a forced test, and Fig. 3 the condition of the filament at the end of a normal life test.

Figs. 4 to 6, inclusive, are representative of the drawn wire filament in the same steps as just described for the pasted type filament. Attention is called to the more apparent uniformity of the drawn wire filament over that of the squirted filament.

These micrographs at the present time, beyond being interesting, can hardly be said to be of any great material value to lamp manufacturers. With their aid, however, as has been the case with other products, it is hoped that some valuable information may be obtained.

The drawn wire filament permits of being mounted in one continuous piece, and it can be mounted similar to that of the tantalum filament, the ends being clamped in the leading-in wires, which was not possible with the pressed filament. The arrangement of the two types of filaments for the 25 watt lamp is shown in Figs. 7 and 8, Fig. 7 being that of the pressed type and Fig. 8 that of the drawn wire type.

By referring to these cuts, it will be noticed that the drawn wire filament lamp has a wider spread of spider, but the distance between the upper and lower

Fig. 4.

support is considerably less. This is an advantage for the reason that the filament on the shorter support has less tendency to sag than it does on the longer one. The sag and interlocking of the filament in the pasted type lamp was cause for occasional complaints. As is evident, the shorter mount obviates this difficulty entirely.

This improved method of support and attachment to leading-in wires allows the filament more leeway for contraction and expansion. The allowable lateral movement is also increased, which movement probably has a tendency to better resist sudden jars than the rigid connection. This added flexibility has allowed the use of the "Mazda" lamp in service hereto-

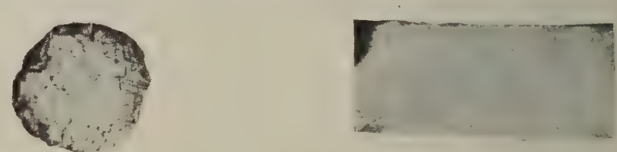


Fig. 5.

fore considered the exclusive field of carbon and tantalum lamps.

As illustrative of this, "Mazda" lamps with the drawn wire filament are being used in street railway and interurban cars. Generally five lamps are used in series, for such service, and are selected for series burning, the 25 watt lamp having an efficiency of about 1.40 w. p. c. and the 40 about 1.35 w. p. c.

The first trial of the 40 watt lamp has progressed over 2,100 hours burning, and the results to date show 58 per cent of the initial number actually burned out,

Fig. 6.

although a number of the lamps that should show as remaining have been stolen or broken. Taking into account those stolen, broken and burned out, the average life performance of all lamps shows 984 hours to date of Nov. 21, 1911, while considering only those

actually burned out, the average life performance has been 1,452 hours.

A number of installations with 25 watt lamps are now being tried out, but none have been in service as long as the 40 watt lamps just cited, although as far as they have progressed, the indications are that they will give at least a performance equal to the 40 watt lamp.

Practically all the 6 volt lamps for automobile lighting are of the drawn wire "Mazda" type, while a very large proportion of the 21 to 90 volt range for electric vehicles are being furnished in the "Mazda" types.

Very few train lighting lamps in the 30 and 60 volt ranges for steam railway service are of carbon or tantalum types. In fact, these two types of lamps can now be considered as special lamps only, having been superseded by the "Mazda" drawn wire type.

In addition to stores, offices, theaters and street lighting, thousands of the "Mazda" drawn wire filament lamps are being used for industrial lighting, railway machine shops, round house, smith shops, foundries and freight yards, and there can be little

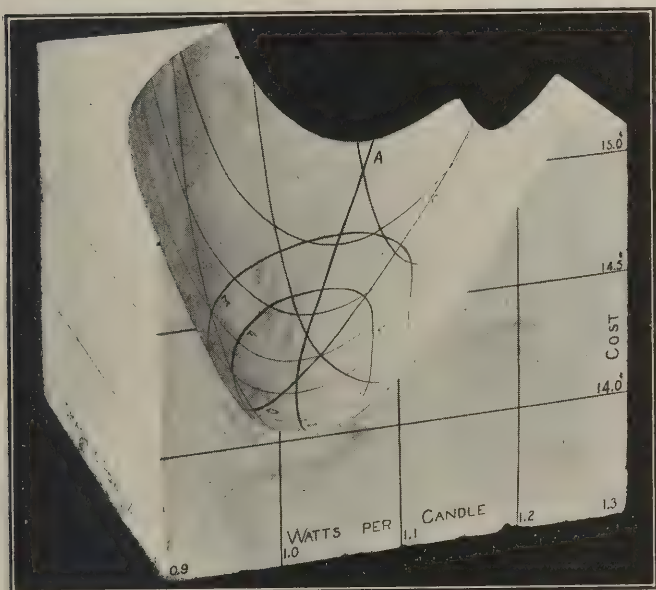


Fig. 9.—Space Diagram.

justification for the use of any carbon filament lamps for any service except in such places where the lamp breakage is especially excessive.

Now that a highly efficient incandescent lamp has been produced which will withstand rough service, it would appear at first thought as though the goal has been reached. Such, however, is not the case. The efficiency at which a lamp should operate is a material factor from the most economical performance standpoint.

A few words of explanation as to what may ordinarily be expected in the performance of a lot of lamps will assist in understanding the details of the method of arriving at the best efficiency.

Suppose we put up an installation of one hundred lamps, starting with a certain initial wattage, say 40, giving a certain initial candle power, say 32, at a corresponding efficiency of 1.25 w. p. c. As these lamps continue burning, the candle power will slowly decrease. During the first few hours, probably none of the lamps will burn out. Then with a gradually increasing rate they will fail. When the lamps have finally reached some low percentage of their initial candle power, say 60 or 50 per cent, there will be but one or two lamps left. Those that are left will be of such a low candle power that they might be economically discarded. Depending upon the conditions of service for which lamps are to be used, there might be some point earlier than the ultimate burnout at

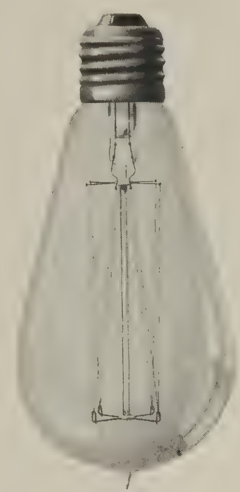


Fig. 7. Squirted Type.

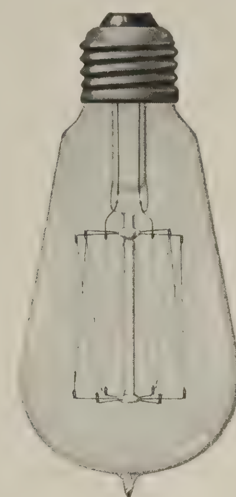


Fig. 8. Drawn Wire Type.

which it would be desired to discard the lamps. For instance, if a very uniform illumination is desired, any lamp which reaches, say, 80 per cent of initial candle power, might be discarded and replaced by a new one. In this case, we would call 80 per cent initial candle power the smashing point, or point at which the lamp is to be replaced. In most installations, however, the smashing point would be governed by the ultimate life of the lamps, that is, they would be left in circuit until they had all burned out. In this case, the smashing point would not depend upon

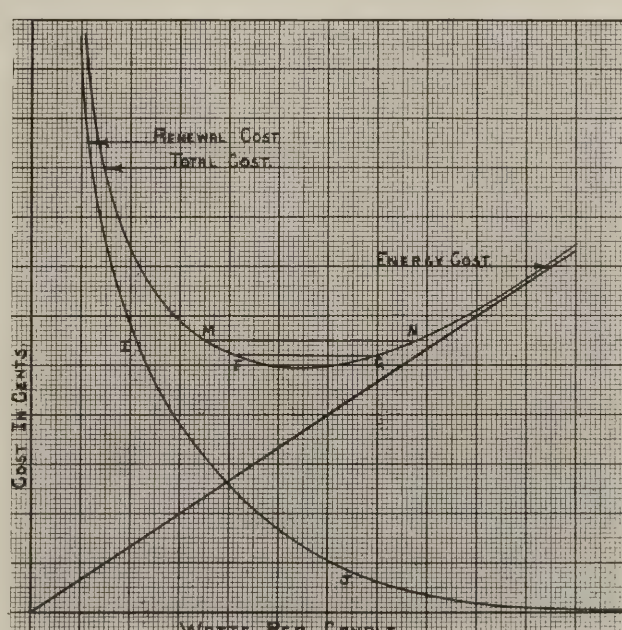


Fig. 10.—Curve of Lamp Economics.

any economical considerations, but would be governed by the quality of the lamp.

Suppose we assume that lamps were to be left on circuit until the end of the ultimate life. The total cost of producing light under these conditions would be composed of two elements, the cost for energy,

and the cost for renewals. The cost for energy would depend directly upon the w. p. c. at which the lamps were burned, that is, if the lamp consumes 1 w. p. c it will use 1 watt-hour in giving 1 candle-hour, and a certain expense would be entailed. If the lamp consumes 2 w. p. c. it will use 2 watt-hours in giving 1 candle-hour, and the expense will be doubled, similarly if it consumes 3 w. p. c., the expense would be tripled. Plotting energy cost per candle-hour against w. p. c. we have a straight line rising at a uniform rate. Now, as to the part of the total cost of light which we have termed renewal expense.

A "Mazda" lamp burning at 3 w. p. c. would live an indefinite time, hence the renewal expense per candle hour would be practically nothing. At 2 w. p. c. the life of the lamps would be considerably shorter. Hence the renewal expense per candle-hour would be somewhat increased. At 1 w. p. c. the life would be still more shortened and the renewal expense would again be considerably increased. Below 1 w. p. c. this curve would rise very steeply. We cannot conceive of a lamp operated at such a high efficiency that it gives light for no energy at all, but if such were possible, the life of the lamps would be infinitely short and the renewal expense would be infinitely great.

The relation between renewal expense per candle-hour and w. p. c. might be illustrated graphically by Figure 10. The total cost of producing 1 candle-hour at any efficiency would then be the sum of the compounding ordinates to the straight line and the curve IJ. It will be noticed that at some operating efficiency, such as 1.13 w. p. c. in the diagram, the total cost per candle hour is a minimum under the conditions assumed, that is, allowing the lamps to run to their ultimate life, 1.13 w. p. c. would then be the best efficiency of burning. It is, of course, evident that some definite price of lamps and some definite rate for energy must be assumed to definitely locate these curves, for depending upon the price of lamp and rate for energy the curves will move up and down relative to one another, and the point of best efficiency would move toward the right or the left, for any conditions of burning, such as we have above assumed, and any fixed price of lamp and rate for energy have a point of best efficiency which is definitely fixed.

It will be noted that the curve of total cost is rather flat at its lowest point, or in other words quite a considerable range of variation in efficiency would not entail a very great increase in the total cost of light.

If we should locate the points F and G, corresponding to a cost 1 per cent greater than the minimum cost, any efficiency between F and G would not entail more than 1 per cent increase above the normal cost. Let us now assume that we should trim the sheet along the total cost curve, cutting off the upper portion. The upper edge of this sheet would then represent the total cost curve for the given conditions. Suppose now that some conditions should be encountered under which it would be desired to burn the lamps only to 80 per cent initial candle power, for instance. Under this condition, the energy expense per candle hour would be slightly decreased, owing to the somewhat higher average efficiency throughout the life to 80 per cent. The renewal expense would be somewhat increased due to the fact that some of the lamps would be discarded before they had actually burned out.

Regardless of the actual magnitude of these two components, the total cost curve would still have a shape very similar to that shown on the diagram. It would have a minimum point and there would be a given range in efficiency over which the total cost would not be increased more than a given percentage. If we should now make up a large number of these curves, say for every 1 per cent in smashing point from 90 per cent down to 60 per cent, and should then stand these sheets of paper up along side each other, the top edges would form a surface. This surface would then show the variations in total cost which would be occasioned by variations, not only in efficiency, but also in smashing point. The photographs which you have were taken from a solid block built up in this manner. The curves parallel to the front edge are exactly similar to those shown on the diagram, that is, their minimum points, show the best efficiency for any given smashing point. This model was made up for 40 watt "Mazda" lamps, considering a list price of 70c and an energy rate of 10c per kw.-hr. The points F and G on the diagram at a cost 1 per cent greater than minimum are represented on this model by the curve FG. Similarly, a curve MN represents cost 2 per cent greater than the minimum. If lamps are operated at an efficiency and to a smashing point which would be represented by some point within the area FG, it will be noted that the light will be produced at a cost not more than 1 per cent more than the minimum. Assuming a 70 per cent smashing point, that is, that lamps will be discarded after they have reached 70 per cent initial candle power, it will be seen from the photograph that the efficiency of the lamp could be varied between the limits 1.0 and 1.13 without entailing a cost more than 1 per cent greater than minimum. Light would be produced at an absolute minimum cost when the efficiency and smashing point are such as is represented by the very lowest point on the surface of the model. The two curves AB and CD are drawn on surface so that they will pass through this bottom point, which you will see is at 72 per cent smashing point and 1.07 w. p. c. Operation to a given smashing point would be represented by a curve parallel to the front plane. Any curve so drawn would have a minimum at a certain w. p. c. The curve AB is drawn through all such minimums. Depending upon the smashing point to which it is desired to operate lamps, it is then seen that the best efficiency varies from about 1.03 to 1.22 w. p. c., with considerations of absolute minimum cost very much in favor of the higher efficiencies.

In carbon filament lamps the filament conforms somewhat to the shape of the lamp bulb and the normal blackening from long life is distributed very uniformly over the entire bulb. Consequently the reduction factor changes only a very little with service and the total light flux veries approximately in a direct ratio to the mean horizontal candle power during the normal life.

When the mean horizontal candle power in a straight sided bulb lamp has reached 80 per cent initial value, the mean spherical candle power will have reached approximately 80 per cent of its initial value, also.

This, however, does not hold good with the "Mazda" lamp, when the filament is in one continuous piece and is mounted on a spider similar to that of the regular tantalum lamp, for the effect of service is to darken the bulb in a distinct band about the horizontal projection of the wire of the filament, due to the relatively short length and to the proximity of the filament to the side of the bulb. This distribu-

tion of blackening serves to reduce the mean horizontal candle power. The reduction in mean horizontal candle power results only in part from the absorption of light by the dark band, as a part of the reduction is due to the fact that some of the light that would normally pass through the bulb in a horizontal direction is reflected from the sloping sides of the bulb through the tip of the lamp. The mean spherical candle power, therefore, does not decrease nearly as much as does the mean horizontal candle power and consequently the change in mean horizontal candle power with service can be no criterion of the real lamp performance, since light is reflected through the tip end of the lamp as it becomes old.

The mean lower hemispherical candle power does not decrease as much as either the mean horizontal or mean spherical. Therefore, in order that the "Mazda" lamp may show the same percentage depreciation in mean spherical candlepower as the carbon lamp, it should be run to approximately 75 per cent mean horizontal rather than to 80 per cent. Since 80 per cent of the initial candle power is on the flat part of the life curve it follows that the difference in life between 80 per cent and 75 per cent would be nearly 20 per cent additional to the life. Therefore, it would be unjust to base the performance of the "Mazda" lamp on the life to 80 per cent mean horizontal candle power as with the carbon filament lamp.

SHOP SECTION

EDITED BY GEO. W. CRAVENS

Shop Series 9—New Orleans Great Northern Ry.

It is frequently harder to design and construct a small project with any very great degree of economy, relatively, than it is a large one, but the locomotive and car repair shops of the New Orleans Great Northern Railroad at Bogalusa, La., are a sufficiently good example of such a result as to warrant special reference.

The location of these shops is about 70 miles north of New Orleans on the main line of the railroad, the shops being directly opposite the passenger station at Bogalusa, thus making inspection of through passenger trains convenient. The layout of these shops is especially noticeable because of the logical arrangement. For example, locomotives coming onto the turntable, pass directly over the cinder pit, and when leaving they pass the water crane, sand house, oil house and coal pockets in order given. The coal pockets have aprons on both sides, thus allowing locomotives to be coaled on either the main line or the siding.

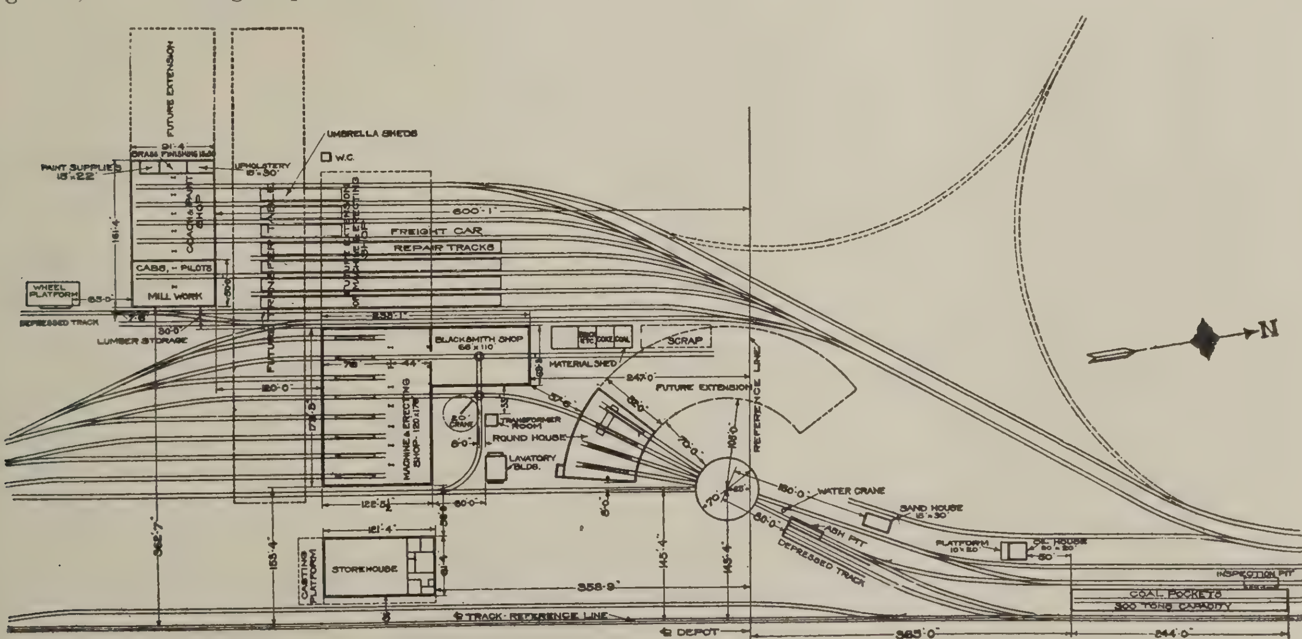


Fig. 1.—Layout of Shops.

There is no generating station at these shops, electric power being purchased from The Great Southern Lumber Co., about one-half mile away. Three-phase alternating current at 2,300 volts is brought into a substation and transformed to 460 volts for the motors and arc lamps and to 110 volts for incandescent lighting. Allis-Chalmers three-phase induction motors are used throughout and Western Electric arc lamps are installed in yards and buildings. With a few exceptions, group drive is used for all machines.

Sub-Station.

The power plant consists of a transformer house, is a concrete building 16 ft. square, located between the round house and the erecting shop. In this building are three 75-K.W. Westinghouse single-phase 2,300-460 volt power transformers connected in delta and a small three-phase 2,300-110 volt transformer for the incandescent lamps, together with the switchboard.

The incoming line is equipped with lightning arresters, choke coils and disconnecting switches, and is controlled by 2 separate, automatic overload release oil switches. One of these switches is for light and the other for power, and they are both on a single slate panel with integrating and indicating watt-meters, ammeters, voltmeter and

a power factor meter. From the transformers the low tension wires are carried overhead to the distributing panels in the shop tool room.

These panels contain a voltmeter, ammeter and multiple point switches for both instruments in order that the current and potential of any circuit may be read at any time. Each motor in the shops is controlled by a starting compensator and protected by fuses when starting. When running, both fuses and automatic circuit breakers with no-voltage release coils are in circuit.

Shop Layout.

The arrangement of these shops is such as to provide terminal facilities as well as for general repairs. There are five main buildings and seven smaller ones and sheds, and each department is laid out so as to allow for 100 per cent extension without interfering with other things. The yards and buildings are served by standard gauge tracks, the locomotive and coach shops being served by a series of ladder tracks which will later be superseded by a transfer table running between the two buildings. Most of the buildings are of reinforced concrete.

The main buildings comprise the Locomotive Shop with its auxiliary shops, the Coach Shop, the Engine House, the General Storehouse and Office Building, and the Locomotive Coaling Plant. Besides these there are the Oil Storage House, Lavatory Buildings, Transformer House, Storehouse and Pits.

In addition to the locomotive and car repairs, this shop is equipped to handle the repair work on locomotives, log rollers, cars and skidding machines of the Great Southern Lumber Co. At present the plant has facilities for handling 50 standard locomotives, 20 geared locomotives, 10 steam log loading and skidding machines, and 5 steam log loaders; also, repairs on 3,000 freight and logging cars and 30 passenger cars.

Locomotive Shop.

The locomotive department includes the erecting, machine, forge and boiler and tank shops in one building 176 ft. long by 120 ft. wide, with a wing at the west end 66 ft. wide by 110 ft. long. The forge shop occupies this wing, together with the tool room. There are eight concrete engine pits in the erecting bay, spaced 22 ft. on centers. The steel columns of the building are designed to carry a 100-ton crane, but a 5-ton hoist is the only one now installed. This shop is unusually well lighted and ventilated.

The machine tool equipment is sufficient for more than present needs, and the layout is such that work will progress through the shops with the minimum amount of handling. The tools in the machine and boiler shops are divided into 3 groups, each driven by a 40-h. p. induction motor mounted on a column of the building by a steel bracket. The line shafts are so arranged that in case of motor trouble each section may be coupled to the next section and the principal tools operated temporarily by the other motors.

One of the groups includes lathes, driving wheel press, shapers, milling machines and drill presses. A second group takes in planers, boring mills, slotters, grinders, etc. The third group comprises the boiler and tank shop machinery, pressure pump for shop water supply, etc. The machinery in the tool room is driven by a separate 5-h. p. motor, but provision is made for attaching to the forge shop line shaft in case of necessity.

A number of jib cranes are provided for stripping and assembling locomotives, and similar cranes of from 1 to 4 tons capacity are located near all of the heavier machine tools. These are Whiting cranes equipped with Yale & Towne hand operated hoists. The 5-ton electric traveling hoist in the erecting bay is equipped with three-phase 460 volt motors and controlled from the floor. The tools in the forge shop are driven by a 30-h. p. induction motor and are served by two Whiting 4-ton post cranes.

Locomotive Dept. Tools.

TABLE I.

Machine Shop.

One 84-in. Niles double driving wheel lathe.
One 38-in. x 16-ft. engine lathe.
One 24-in. x 16-ft. Le Blond engine lathe.

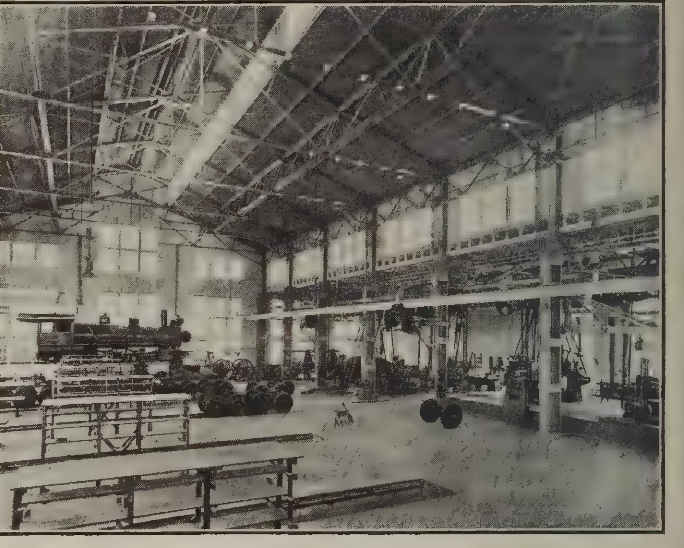


Fig. 2.—Erecting Bay of Locomotive Shops.

Two 18-in. x 10-ft. Le Blond engine lathes.
Two 16-in. x 8-ft. Le Blond engine lathes.
One 2 x 26-in. Pratt & Whitney turret lathe.
One 42-in. Niles vertical boring mill.
One 24-in. Acme crank shaper.
One No. 2, Le Blond universal milling machine.
One 30 x 30-in. x 8-ft. planer.
One 48 x 48-in. x 24-ft. Pond 3-head planer.
One 36-in. Aurora drill press.
One 24-in. Aurora drill press.
One 5-ft. Niles semi-universal radial drill.
One 20-in. "D" Standard dry grinder.
One 84-in. Niles hydraulic wheel press.
One 18-in. Bement slotter.
One 23½ x 32-in. Bement No. 0 horizontal boring mill.
One 16 x 5-in. Universal turret lathe.

Fig. 3.—Locomotive Machine Shop.

One 35-ton portable hydraulic rod bushing press.
One 2-in. bolt cutter.
One 2-in. Acme 6-spindle nut tapper.
One 21-in. drill press.
One 225-cu. ft. power driven air compressor.
One 8 x 10-in. Deane triplex power pump.
One 48 x 6-in. Pond grindstone.

One 3¼ x 8-in. portable cylinder boring bar.
One 26-in. portable valve seat rotary planer.
One 12-in. spiral belt lacing machine.

Boiler and Tank Shop.

One No. 2 L. and A. double punch and shear.
One ¾-in. x 10-ft. Niles plate bending rolls.
One 10-ft. Niles plate flanging clamp.
One 4-in. Cox pipe-thread and cut-off machine.
One large blower.

Flue Shop.

One Otto flue cleaner.
One pneumatic flue welder and scarfer.
One 14 x 15-in. coke furnace for flue welding.
One vertical, revolving flue rack.
One No. 6 Fox flue cutter.

Forge Shop.

One 2-in. Acme bolt head and forging machine.
One 24 x 5-in. coke furnace for bolt header.
One 500-lb. Beaudry power hammer.
One 30 x 7½-in. coke furnace for power hammer.
One No. 11 Buffalo Blower.
One 14 x 5-in. coke furnace for case hardening.
Two face plates.
Nine railroad forges.
Two frame fires.

Tool Room.

One 18-in. P. & W. improved tool room lathe.
One Yankee "P. O." twist drill grinder.
One Blount wet drill grinder.

Car Shops.

The coach shop is 161 ft. long by 91 ft. wide with track doors on both sides, thus making it possible to make all of the tracks run through at a later date if desirable. A 50 ft. section is partitioned off by an 8 inch concrete wall, at the east end, for the wood working machinery, and one track runs into this room. At the west end of this building a space 20 ft. wide is partitioned off and divided into 3 rooms 30 ft. long for brass finishing, paint supply and upholstering rooms. The main central portion 90 ft. by 90 ft. contains 4 tracks on 20 ft. centers and is used as the coach repair and painting shop.

Freight car repairing is done just west of the locomotive shops on the tracks running to the coach shop. The climate of southern Louisiana is such that work may be done out of doors most of the year. Between the tracks here are erected a series of umbrella sheds for the protection of material and workmen in case of storms. These sheds vary from 100 ft. to 250 ft. in length.

The tools required for car wheel work are located in one corner of the wood-working shop and comprise a car wheel borer, double head axle lathe, hydraulic wheel press, etc. The wheel storage platform is located just outside the building with a depressed track, adjacent, for loading and unloading wheels.

The line shafting in the car shop is supported from the roof trusses by 4 inch by 12 inch latticed wood struts. The machinery is divided into 2 groups, each operated by a 40-h. p. induction motor mounted on overhead platforms.

Car Department Tools.

TABLE II.

Car Wheel Shop.

One No. 2 Niles double axle lathe.
One 42-in. car wheel borer.
One 300-ton hydraulic wheel press.

Woodworking Shop.

One 36-in. Fay and Egan rip saw.
One 16-in. double arbor universal saw bench.
One 36-in. Greenlee automatic cut-off machine.
One vertical automatic hollow chisel mortising machine.
One Fay & Egan variety wood worker.
One Fay & Egan double spindle shaper.
One 15 x 8-in. Berlin open side moulder.
One horizoneal car tenoning and gaining machine.
One Fay & Egan planer nad smoother.
One 36-in. F. and E. band saw.
One 18-in. F. and E. speed lathe.
One 40 x 6-in. Pond grindstone.
One Fox bench wood trimmer.

Round House and Stores.

The engine house is planned to allow of extension enough for about 20 stalls, though but 4 are now in place and the building quite small. It is 82 ft. wide with a 70 ft. turntable at the center point, the space from wall to table being also 70 ft.

Two of the four concrete engine pits are connected by a driving wheel pit in which wheels are handled by means of a traveling pneumatic jack of the telescoping type. The smoke jacks are of Vitribestos, quite large, and suspended from the roof purlins by heavily asphalted iron rods. A wide central monitor in the roof provides both light and ventilation.

The main storehouse is 121 ft. by 61 ft. and is of reinforced concrete and slow burning wood construction with a corrugated iron roof. A space 30 ft. long at the north end of this building is partitioned off and divided into rooms suitable for offices for the master mechanic, clerks and storekeeper, and as storerooms for stationery, etc.

The balance of the building constitutes the main storehouse for the storage and handling of the general supplies required for the operation and maintenance of the railroad. The floor is 4 ft. above the tracks for convenience in loading and unloading, and an inclined runway or ramp at each end of the platform provides easy access to grade for trucking. A canopy over the platform protects the men and material from bad weather.

The coal storage bins are of steel in a wood structure 244 ft. long and have a capacity of 300 tons. A 40-h. p. induction motor pulls the cars up the incline and the arrangements are such that a loaded car weighing 150,000 lbs. can be hauled up at the rate of 30 ft. per minute. The bunkers are equipped with 4 steel aprons, two on

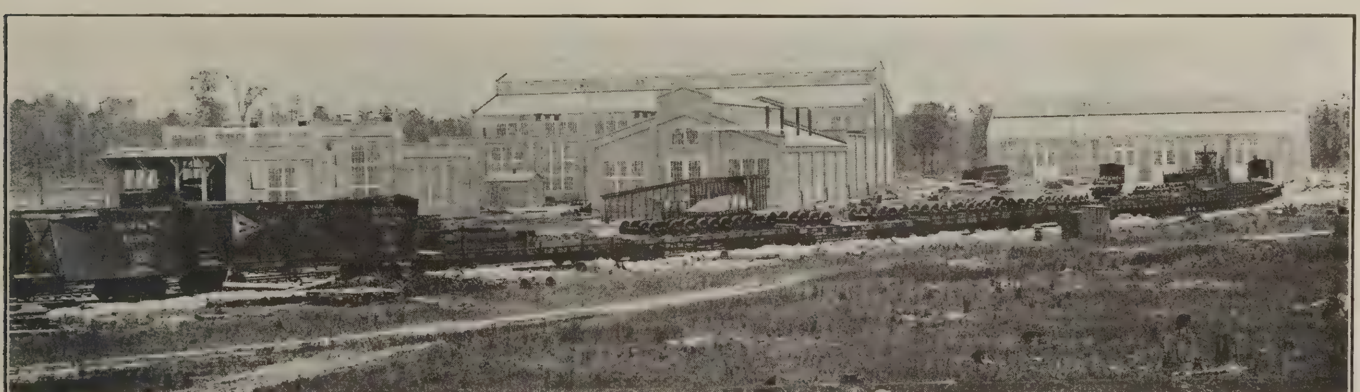


Fig. 4.—General View of Shops.

each side, so coal may be dropped by gravity into tenders on either track.

The oil storage tanks are of concrete lined with metal, and the combined capacities of the five are 23,000 gallons. Each is provided with a hand pump and a galvanized iron sink. The sand house is of wood, 15 ft. by 30 ft., and bins for both wet and dry sand are provided.

Lighting and Yards.

Arc lights operated from the 2,300-460 volt transformers are installed in the principal buildings and throughout the yards. There are about 30 of these, of which one half are in the locomotive shop, three in the engine house and the rest in the yards. By using 460 volt lamps they may be operated from the power circuits and the wiring simplified. For protection from short circuits, these lamps are provided with double-pole cutouts at connections to mains. The arc lamps in the engine house are arranged for connecting direct to conduits by tapping holes in the tops, the conduit forming a hanger.

The lighting throughout the balance of these shops is by incandescent lamps on drop cords and adjustable bench fixtures, there being over 200 installed. At a large number of places extension plugs and receptacles are provided to allow extra lamps to be used. All wiring is placed in conduits for protection from the corrosive action of fuel gases.

The general arrangement of the buildings with relation to each other and to the transformer house is indicated by the layout here shown. A "Y" track is located in the northwest corner of the yards for turning coaches that are too long for the turntable. This turntable is of the deck type, 70 ft. long, and has a capacity of 180 tons. It is hand operated now but a motor may be installed later. The storm sewer system is designed to carry off all water from roofs, turntable, cinder and wheel pits, the yard areas being taken care of by open drains. The sanitary sewer from the lavatory has a separate lead to the city sewerage system.

Miscellaneous.

A striking feature of these shops is the evident attention paid to appearances and the harmonizing of the building designs and coloring with the landscaping of the town of Bogalusa and vicinity. These shops, with their red roofs, gray walls and white woodwork, surrounded by evergreen forests, present an unusually attractive appearance. It should be a pleasure to live and work amid such surroundings, and with a proper spirit on the part of the management there should be no labor trouble there.

Water for shop purposes is piped from the plant of the Great Southern Lumber Co., nearby, where 5 pumps and an elevated tank are installed. The regular pressure is 45 lbs., but it can be increased to 100 lbs., in case of fire. The yards are well equipped with mains and hydrants, and hose racks containing 50 ft. of hose are located throughout all of the buildings. Drinking fountains are placed in all of the principal buildings.

Compressed air for shop purposes is supplied by an Ingersoll-Rand compressor of 275 cu. ft. capacity. This is belt-driven by a 50 h. p. induction motor and delivers air at 100 lbs. pressure to a large storage reservoir on the roof trusses. From this the air is piped to valved air outlets in the locomotive, forge and coach shops and engine house, and to valves along the freight car repair tracks.

The engineering and construction of the complete plant was done by The Arnold Co., of Chicago, and the writer hereby extends his thanks to Mr. P. L. Battey, chief engineer railway shops department, for his kindness in furnishing the data upon which this account is based.

Methods of Varying Speed of A. C. Motors

Abstract of a Paper Presented Before American Institute of Electrical Engineers

G. A. MAIER

The problem of providing a practical alternating current motor, the speed of which can be adjusted to suit the conditions of service at the will of the operator is one which interests both the electrical manufacturer and the operator of machine shops or factories to which alternating current may be advantageously supplied.

On December 8th, Mr. Gus. A. Maier presented a paper before the 266th meeting of the American Institute of Electrical Engineers in New York. The paper is the first comprehensive statement of the development of the variable speed feature of the alternating current motor, and as such should receive the very careful consideration of all concerned.

The paper takes up the general discussion of methods of varying speed of alternating current motors. The author distinguishes between the adjustable speed motor and the varying speed motor. The former being one in which the speed may be adjusted to any desired value or at least to one of two or more definite speeds whereupon the motor will operate at the desired speed practically regardless of the load; the varying speed motor on the other hand is one which the speed varies with the load applied. It usually varies inversely with the load.

For varying speed work, the following types of induction motors have been used: (1) squirrel cage with primary resistance and with primary compensator control, (2) double squirrel cage with movable starter, (3) sliding armature type and (4) polar-wound armature type; in commutator motors both the resistance and brush-shifting repulsion motors have been used. For adjustable-speed work the following motors have been used: (1) pole changing, (2) frequency changing, (3) shunt repulsion, and (4) induction motor in connection with shunt-repulsion commutator motors.

The polar-wound induction motor with variable resistance in the rotor circuit is best adapted to variable speed as the losses necessary to obtain reduced speeds are external to the motor itself. The rotor currents are collected from slip rings and transferred to the external resistance circuit. In the other types of variable speed motors the losses incident to change of speed are, for the most part, absorbed within the motor itself, requiring that motors of this type be larger and therefore rather expensive. The polar-wound armature has other advantages, namely: better inherent speed regulation, small line current required, the slip is less, power factor higher, and the efficiency relatively high throughout the entire range.

In regard to the commutator type single-phase motor the author considers briefly driving an ordinary series wound direct-current motor with alternating cur-

rent. Where alternating current is used, however, the compensating winding is necessary.

The author then described various methods of obtaining compensation which include motors invented by Elihu Thomson, Winter & Eichberg and LaTour. The speed characteristics of these motors can all be considered as equivalent to the direct current series type.

Brush shifting commutator motors known as the Deri type are used to some extent for hoists, cranes, and railway traction work. The machine possesses speed—current and speed-torque characteristics of the direct current series motor.

On account of the fact that some of the armature coils are rendered inoperative by the shifting of the brushes, this type of motor must be built larger than one with stationary brushes.

The induction motor as usually spoken of is primarily a constant speed motor. Where variable speed is required, a motor with collector rings is used, the speed variation being produced by varying the amount of resistance in the secondary or rotor circuit. Many times it so happens, however, that two or three speeds will be satisfactory to meet the demands of a certain class of service, in which case the multispeed motors can frequently be used. In these motors the different synchronous speeds are produced by the number of poles in the magnetic circuit. A further speed adjustment for intermediate values may be obtained by either primary or secondary resistance as in the varying speed type mentioned above. One of the objections to the multispeed motors has been that it becomes necessary to change the primary circuit in changing the connections so as to provide a greater or lesser number of poles.

Multispeed motors are in industrial use to considerable extent today, the several speeds being obtained by changing the number of poles by some switchover device, or by concatenation of two motors, or by combination of several of these methods which result in an excellent gradation of speeds.

Recently there has been brought out in England, the Hunt or internal concatenated motor. The machine is a modified form of the "cascade" motor, having two magnetic field systems superimposed upon one, the other in the same core body. The second field has its origin in the rotor and consequently induces secondary currents in the stator windings.

The motor can be laid out for cascade speeds of 12, 18, 24 poles, i. e., numbers divisible by six, the lowest number of poles being 12. A motor having a smaller number of poles is not satisfactory, as the resultant magnetic field is not symmetrical.

Considering an eight-pole stator winding with taps brought out in such places that the winding can be made responsive to a four pole field. The motor has a winding which gives the effect of an eight-pole and four-pole winding in series. The motor can operate either in cascade with a speed corresponding to 12 poles or as an eight-pole motor. In order to obtain three effective speeds a change over switch is necessary in the stator circuit. This enables the connections to be changed so that the primary currents may produce either an eight-pole or a four-pole magnetic field.

Although no figures are available, it appears possible with Mr. Hunt's methods to design a cheaper two-speed motor than the ordinary collector ring type with two primary and two secondary windings. On account of the whole winding being used all the time, this type of motor ought to have a better efficiency and power factor than a double-wound motor.

With this construction it seems possible to obtain a motor of smaller size and cost with better constants than a two-speed collector ring motor or cascade set. Continuous acceleration is possible by means of rheostats without opening the main circuit.

The author then describes the method of varying motor speed by varying frequency and voltage impressed. This principle, however, involves either a motor generator set driving from direct-current circuit, the speed of which may be varied at will so as to produce proper voltage and frequency in the alternating current motor circuit; or, if the source of supply is an alternating-current one, the motor generator set must consist of a driving alternating-current motor having, say 12 poles and as many generators as additional speed values are required, these to be of 1,086 poles, etc. It is obvious, however, that this method of changing the speed of an alternating-current motor is a very expensive and cumbersome one; in fact, so much so that it becomes a theoretical consideration only.

The author continues with a description of the adjustable speed single phase motor, going into its theory to some length.

The polyphase motor is described and diagram of various combinations of series and shunt field windings is given.

The author concludes his paper with a description of the Kraemer and the Scherbuis systems which have found some application in Europe.

Considerable progress has been made in the use of alternating-current commutator motors in Europe. The brush shifting motor as originally developed was a single phase motor, but is now built in the three phase type. The simplest arrangement for three phase operation is to use two single phase motors "T" connected.

The author says that various modifications of the Kraemer and Scherbuis systems have been used in Europe showing excellent results as to regulation and economy of operation.

THE TESLA STEAM TURBINE.

Since the advent of the steam turbine which has subsequently been developed to such a degree as to very largely replace reciprocating engines, there has possibly been nothing which has attracted the attention of the mechanical world more than the new Tesla turbine. Several types of power apparatus, both driving and driven, embodying the underlying principles of this novel turbine design have been built and tested in the Tesla laboratory. One of these turbines has

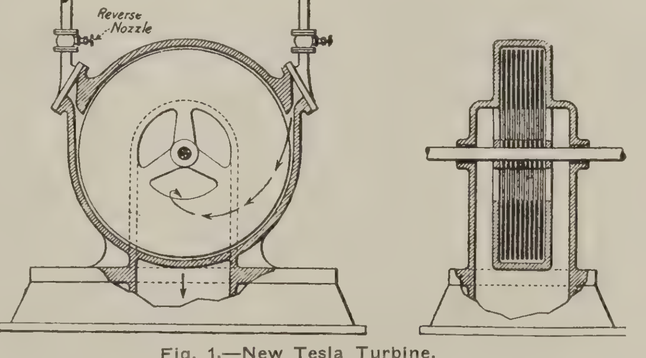


Fig. 1.—New Tesla Turbine.

been in actual service at the water-side station of the New York Edison Company for several months.

The turbine consists essentially of a rotor made up of 25 steel discs 18 in. in diameter. The assembled unit occupies a floor space of about 20x35 in. and stands about 5 ft. in height. With steam at 125 lbs. gauge pressure and exhausting to the atmosphere, 200 h. p. was developed at a speed of 9,000 r. p. m. Steam consumption under these conditions was about 38 lbs. per h. p. r. The weight of the unit is about 400 lbs.

Mr. Tesla states that with moderate superheat and with the degree of vacuum ordinarily obtainable in a

steam turbine plant, steam consumption can be reduced to 10 or 12 lbs. per h. p.-hr.

Through refinement in design in addition to the increase of capacity secured through superheat and vacuum, Mr. Tesla expects that the weight may be reduced to as low as ¼ lb. per h. p. capacity and still permit of designs which will have rotational speeds low enough for direct connecting to the majority of services.

The principle underlying the operation of this turbine is such a novel one that it becomes worthy of special consideration. Instead of providing vanes or buckets as with the ordinary turbine of the impulse type, this turbine operates on the principle of skin friction of the gas passing at high speed over a flat surface. Steam is emitted from a nozzle which is designed to provide proper expansion, so that the heat energy of the steam is converted into kinetic energy. This high velocity steam escaping from the nozzle impinges tangentially on the edges of the discs and enters the very narrow spaces between them.

In passing from the nozzle to the exhaust outlet at

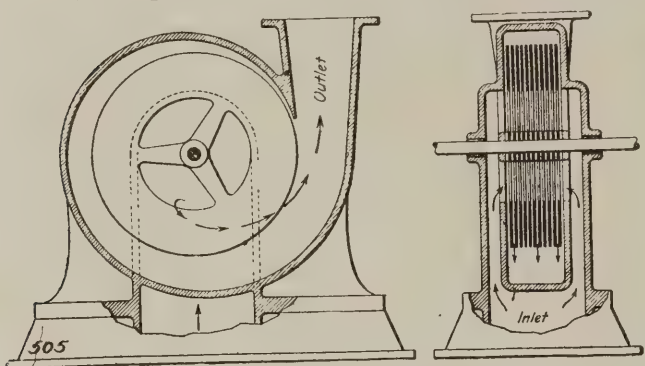


Fig. 2.—Modification of Turbine as Pump.

the center of the rotor the steam makes several revolutions in a spiral path. In so doing, and on account of the very large contact surface with the rotor discs, the velocity energy of the steam is utilized through the frictional resistance which the disc surfaces offer to the passage of the steam. With such a nozzle it is seen that the machine is essentially of the so-called "impulse" type of turbine.

The turbine, as shown, has a very simple and convenient means of reversing, it being merely necessary to provide a duplicate nozzle discharging against the opposite diameter of the discs in the opposite direction. It is evident that the torque developed by the discs increases with the difference in peripheral velocity of the discs and of the fluid and contact. If the shaft were blocked so that it could not rotate at a high speed, however, the steam on leaving the nozzle would take a much more circular path and become subjected to a strong centrifugal force which would tend to oppose its flow from the periphery to the center of the disc. With the shaft running light with no load applied, this centrifugal effect will very nearly balance the component of force toward the center so the steam consumption will be automatically reduced to some degree with a decrease in load. Such a prime mover will give its maximum output at about 50 per cent average slip, but the maximum efficiency will come with a comparatively small slip.

The same principle may be applied to the design of a pump, the direction of fluid flowing through the rotor would, of course, be reversed. Mr. Tesla has designed several pumps of this type, one of which is shown in Fig. 2.

On studying this principle as applied to a pump, it becomes more evident that the turbine is fundamentally one of the "impulse" type, for when operating as a pump the fluid is taken in at the center, caught between the revolving discs and whirled to their periphery and to the outlet of the pump by centrifugal force as in any centrifugal pump.

One of the main objections to the turbine is, of course, its high velocity and the incident difficulty in obtaining efficient gear drive.

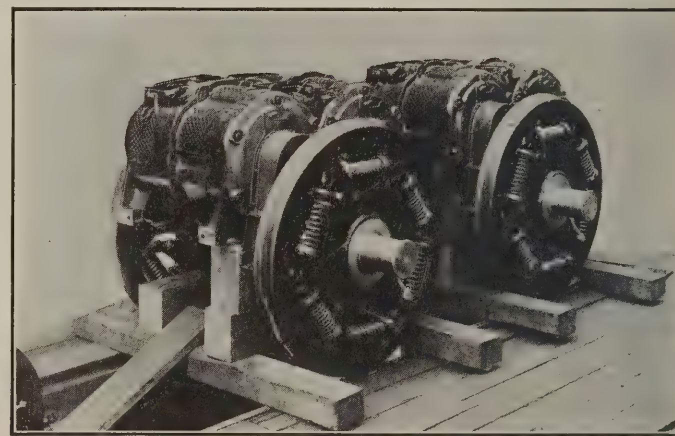


Fig. 1.—Motors Removed from Axle.

The design is apparently equally applicable to the operation of any gas motor and an internal combustion engine may be developed, which on account of its extremely light weight, will find special application in aerial navigation.

DEVELOPMENT IN ELECTRIC RAILWAY APPARATUS DURING THE PAST YEAR.

During the past year considerable progress has been made in the development and improvement of electric railway apparatus. The increase in the number of applications of the single-phase system has been particularly noteworthy. The latest single-phase locomotive built by the Westinghouse Company is equipped with four driving axles (Figs. 1 and 2), and has eight motors, there being two single-phase motors geared to a quill surrounding each axle. This arrangement,

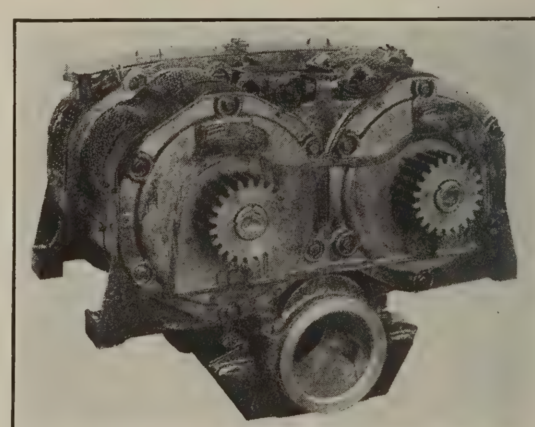


Fig. 2.—Motors Mounted on Axles.

which at first appears more complicated, is in reality, a lighter, cheaper, and more simple construction than that involving four motors of the same total capacity.

Most of the troubles on pioneer single-phase railways were due to operation at abnormally high speeds, at speeds higher than those for which the equipments

were designed. These high rates of speed were possible because the line voltage was always good and because the transformers were usually supplied with overvoltage taps. Furthermore, the motors had very steep speed characteristics, which permitted them to reach a higher speed than would be possible with a direct-current motor with the same gear ratio. This source of trouble is now eliminated in Westinghouse equipments by the use of an overspeed relay, which is electrically operated, and is controlled by the current and voltage applied to the motor through the control circuit. When the speed of the motor reaches a certain predetermined limit, the control circuit is opened on the higher notches of the controller. This makes it impossible to operate the cars above the limit unless there is a long stretch of down-grade, which is unusual on interurban lines. In any event, excess speeds are possible only when there is no power on the motors. This method of protection might safely be applied to direct-current motors, since extremely high speeds are not only dangerous, but in nearly all cases are unnecessary. High speeds are a source of expense because of the extra energy consumption involved, as well as because of the increased wear and tear of equipment.

One of the largest electric railway systems in the South is about to be equipped with 1,500-volt direct-current apparatus. This voltage is considerably higher than that of any direct-current line of the present day, since 1,200 volts has been the highest pressure heretofore used. Standard types of interpole motors especially arranged for operation on 1,500 volts, with two motors permanently connected in series, will be used.

The success of field control on locomotives has been so encouraging that the Westinghouse Company decided to apply it for the control of the ordinary street car motors, for both slow-speed city and high-speed interurban service. The advantage is that the motors may be wound for a very low-speed with full field, which insures a minimum of operation on resistance and with normal field it is possible to operate a car at higher speeds with less resistance. Field control virtually produces a high speed equipment which has an extremely small rheostatic loss in starting.

NEW SANTA FE STATION AT HOUSTON, TEXAS.

In the many magnificent new railway stations recently completed so much attention has been given to the general illumination of the waiting rooms that the matter of individual lighting for each seat, to provide a good reading illumination for passengers, has been more or less neglected.

The tendency has been to place the main lighting fixtures high above the floor, or, as in a few cases, to reflect the light from concealed sources up into a light colored ceiling from which the floor below is lighted by indirect illumination. This provides a perfectly satisfactory illumination for general purposes but is invariably insufficient for reading.

The Santa Fe Railway, however, in their new station at Houston, Texas, have included this individual seat lighting feature in addition to the general lighting effects of the modern station. An inverted trough of art glass having a white inside reflecting surface is mounted on decorative brass standards on the top of the center board of each seat, as shown in the accompanying illustration. The lamps are placed well up in this trough, entirely out of the range of vision.

Interior of New Santa Fe Station at Houston, Tex., Showing Individual Lighting of Seats.

Each seat is provided with twelve 16-candlepower incandescent lamps located in the inverted trough, about 5 feet from the floor level. There are 8 compartments on each side of the seat, so that the 12 lamps on each seat provide good reading illumination for 16 persons. There is also a considerable increase in the general illumination in the aisles due to these reading lamps.

The entire absence of glare with this arrangement is most striking. The main lighting fixtures of the station are placed high and well out of range of vision, and as the only direct light visible from the reading lamps comes through the soft diffusing art glass shade, the effect upon the eye is a most pleasing one. The traveler may there read with all comfort while waiting for arrival and departure of trains.

ELECTRICALLY OZONIZED AIR FOR LONDON TUBE RAILWAYS.

In a recent report an American consular officer states that one of the strongest objections made to traveling underground in London is the fact that the air is impure and often stifling. What promises to be a revolution in this particular is a plan which has recently been announced by the officials of the Central London Railway Company, according to which a system of ventilation will be installed capable of pumping daily 80,000,000 cubic feet of ozonized air into the tube stations and tunnels of that company.

One plant is already in operation, and it is hoped that similar ones will soon be completed at every station along the line. It is stated by one of the officials that the plant at each station will pump 400,000 cubic feet of air per hour into the station, or at the rate of 900 cubic feet per person per hour. The ordinary allowance in buildings is about 300 cubic feet of fresh air per person.

The air is drawn from outside through a filter screen, which removes dust and dirt and impure gases. A part of the air is then highly ozonized by being passed over highly electrified plates, the proportion of ozone in the whole being one part in 10,000,000. The air is driven by electric fans to the level of the bottom of the station, and two-thirds of it is distributed over the platform by ducts, with outlets at a height of seven feet above the platform. The remainder is driven into the tunnel. The size of the pumping plant is such that it can be installed in a chamber 10 feet by 8 feet by 4 feet, and there are two miles of duct work.

A NEW IDEA IN AXLE PULLEYS FOR CAR ELECTRIC LIGHTING.

The subject of supplying electric lights to moving trains is the one which, perhaps above all others, is of the most interest to the members of the Association of Railway Electrical Engineers. It is not surprising, therefore, that the pulley, which transmits the power from the revolving axle of the car to the generator, becomes a topic worthy of much discussion and consideration.

The association has decided, for the present at least, to give the stamp of their approval to a pulley with a straight bore, which shall be mounted on a bushing made to fit the axle, but affording a straight seat on which to mount the pulley. Pulleys and bushings are now on the market which comply with these specifications and they appear to have given fairly good results.

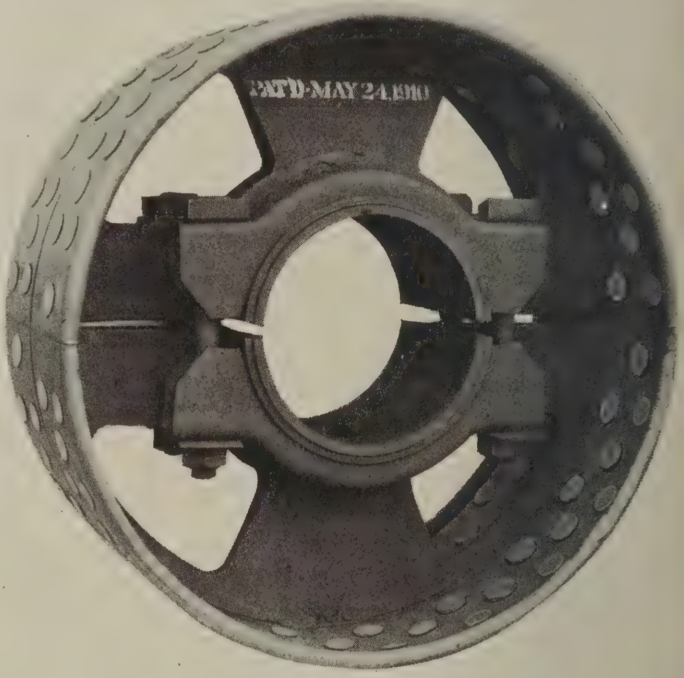
There is one difficulty, however, which is universally experienced to a greater or less degree, and that is the fact of **belt slip,** which allows a variable speed in the generator and consequently a fluctuating current.

With this in mind it has seemed well to call the attention of the interested to a new device which has gone far to solve the problem of belt slip in a number of different industries. The device consists mainly in the application, or insertion, of corks in the surfaces of articles or machines which transmit power by means of friction on these surfaces. One type of machine in which the cork application or insert has been most successful is the belt pulley. The cork insert pulley is being used in ever increasing quantities in textile mills where, of course, a constant speed and no slip is of the first importance. Pulleys for motors and generators are supplied with corked faces with excellent results.

Why not, then, equip our axle pulleys in the same manner?

It will be objected that in textile mills and in other manufacturing establishments, where pulleys are used on line shafts and are relatively clean, an entirely different condition obtains than is the case with the axle pulley on a train. True— but the answer to this objection is that the same insertion of corks has been used with excellent results in automobile clutches and in the clutches on hoisting engines where as bad a condition exists as can well be imagined. The corks do not seem to wear out as one would suppose, and are most pleasantly and unexpectedly disappointing in this regard; the reason, apparently, being that the cork of its own nature possesses a certain compressibility, and it is this slight yielding of the cork fibre which prevents the wear to which an entirely unyielding substance would be subjected.

In regard to the added efficiency of corked pulleys, there can be no doubt. Numbers of tests have been made to prove this. At the Lowell Textile School, alone, some hundreds of tests were conducted, all of



Cork Faced Axle Pulley.

which demonstrated that the corked pulley possesses an increased efficiency over the uncorked pulley to the amount of from 40 per cent to 60 per cent.

The thing has been recently tried in actual practice on an axle pulley by one of the large railroads of the country, and they have written, through their superintendent of motive power, to one of the manufacturers of corked pulleys:

"We beg to advise that ——, Supt. Motive Power, reports that this pulley was applied to car .... and that it has greatly facilitated the output of the machine by eliminating the slipping of belts, and that he has no record of belts slipping on cars equipped with this style of pulley.

"The latter part of this statement applies not only to the pulley which you furnished, but to some other pulleys with cork inserts which we had obtained and are trying out in service."

This certainly looks interesting and is worthy of consideration, if not of trial.

The American Pulley Company, of Philadelphia, among others, have done some experimenting in this line. The cut shows one of their axle pulleys with cork inserts in the face. The method of application is simple and secure, and is controlled by patent.

THE BATTERY TRUCK CRANE.

Railroad men have been very much interested in the installation and operation of the electric freight handling system installed in St. Louis by the M. K. & T. R. R. Now, however, comes an auxiliary freight and material handling device which seems to rival the former as a time saver and a convenience.

The battery truck crane which has just been placed on the market by the General Electric Co., is a short, heavy storage battery vehicle with a swinging jib crane mounted on the forward end. This crane has a capacity of one ton and takes its power for hoisting from the vehicle battery. The storage battery is placed on the extreme rear of the truck and serves as an anchoring weight, as shown in the accompanying illustration.

The applications of the truck are three-fold, viz.: hoisting; hoisting and carrying on the hook; towing trailers.

are well equipped with cranes and industrial railway.

In this hoisting and hauling service, sixty 800-lb. barrels of plumbago were removed 300 feet in one hour. Only one helper was used. One hundred and fifty 300-lb. boxes of rubber were loaded into a box car seventy-five feet distant in fifty minutes. Three boxes were slung together and a round trip was made every minute. In a store room, boxes of angle and flat iron weighing about 1,000 lbs. each were carried thirty feet and stacked in sorted and orderly piles at the rate of forty boxes an hour. One-ton rocks were loaded into trailers from a scattering pile at the rate of twenty-four an hour, and were hoisted two feet and carried about twenty. Two 1,200-lb. water meters were lifted from a hole six feet deep and carried to a shop bench a thousand feet distant in thirty minutes. This gives an idea of the convenience and utility of this little truck when the usual aggregation of gin-poles, tackle, planks, rollers and levers is considered.

Battery Truck Crane.

When it is desired merely to load or unload material and no haul is necessary, the truck is brought into proper position and the hoisting gear put into operation. The boom swings back and forth between the loading and unloading points with each load, requiring no movement of the vehicle.

The company furnishes some data as to the capacity of the crane in unloading material: 360 castings aggregating 65,000 lbs. were removed from a gondola car in 5 hours, making an average of 1.2 lifts per minute. This required the services of but three men, one crane operator and two men hooking the castings.

In hoisting and carrying material, the truck crane plays a very important part. The material is hoisted, the truck gets under way, and in a surprisingly short time the material is deposited where desired whether on the floor, in a pile or in some definite position on a rack.

The wheel base of the truck is short (64 in.), which permits of short turns in the aisles of machine shops or storage yards. Flexibility, simplicity and rapid operation of the battery truck make it well adapted for heavy errand work about shops even though they

In certain instances where there is a large amount of transfer freight through distances greater than about 400 ft. it is recommended that the crane truck be used to tow trailers. To secure maximum efficiency there should be a train loading and another unloading while the machine is on the road between points, thereby avoiding delay. The number of trailers per train and the number of trains will depend on the distance, character of load, and time taken to load and unload the trailers. Twelve is the usual number, divided into three trains, thus working about 600 sq. ft. of loading space to full capacity.

From the logs of a number of these machines, for a long period of service in the Bush Terminal, New York, the following average week's work at towing trailers has been deduced:

Number of packages handled	7,570
Average weight per package	230 lbs.
Total weight handled (900 tons)	1,720,000 lbs.
Average distance packages were moved	900 ft.
Of total time machine was working	80 per cent.
Packages delivered per working minute	3
Number of different jobs worked on	30

Heaviest single load drawn................12½ tons
Cost of operator, inter't, depreciation and power.$24.00
Cost of moving one package 900 ft...........1-3 cent
Cost of moving 1 ton (9 packages) 900 ft......3 cents

The machine is designed for a draw-bar pull of 2,000 lbs. on dry wood block pavement and running light makes a speed of 9 miles per hour; with one ton on the hook, 7 miles per hour; towing 5 tons on trailers, 5 miles per hour.

Battery consists of 44 lead cells, 168 ampere-hour capacity of 13 plates each, and is mounted in 4 crates.

A 1,200 r. p. m., 85-volt, 3¼-h. p. motor with Hess-Bright ball bearings both operates the hoist and drives the truck. The complete weight of the crane when mounted is 5,000 lbs.

THE REVERSITE CIRCUIT BREAKER.

In any electrical system of which the storage battery forms a part, the Reversite circuit breaker is almost indispensable—such an apparatus is an automatic device which instantaneously opens a circuit in event of the direction of current flow being reversed and "which unless immediately interrupted would result in a misapplication of energy."

The efficiency and life of a storage battery are both largely dependent on the manner in which it is handled. If charged at an abnormal rate the plates will become sulphated and will be subject to other forms of injury from which it is slow to recover; should the battery be discharged at too high a rate serious trouble will also be encountered—this will happen if the battery is connected into the charging circuit incorrectly so that its power will tend to add to that of the generating source—this subjecting the battery to an excessively high discharge rate. Such a case may be prevented by the installation of a circuit breaker.

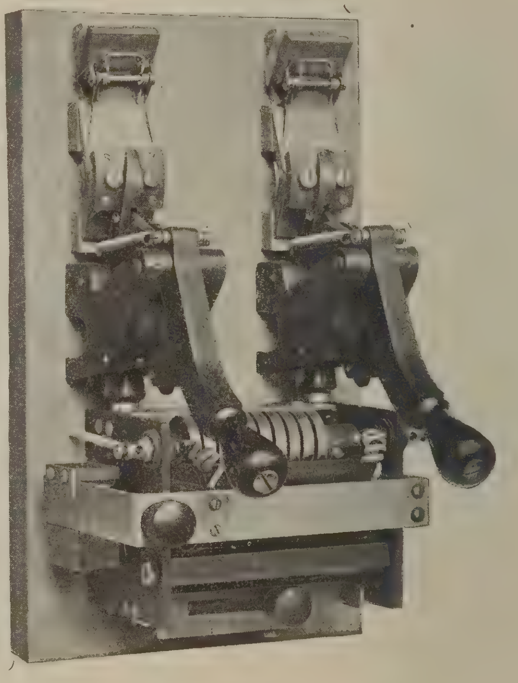
If for any one of a number of possible reasons the voltage of the charging generator is lowered, the battery will reverse or discharge into it and operate it as a motor—if the generator is also supplying current to some other apparatus and should refuse to deliver current at normal pressure the battery will take up the load which might be dangerously heavy for the battery. A Reversite breaker would disconnect the battery as soon as it attempts to do the generator's work.

When batteries are charged from a motor generator the motor end is often in connection with other apparatus—if the motor circuit is opened, the battery, if not promptly cut out, will run the motor generator reversely and supply current to the other apparatus. This situation may also be taken care of by the Reversite form of circuit breaker.

Frequently batteries are installed in parallel with generators on signal work. If the generator fails to deliver its share of the load it can be kept from running as a motor and exhausting the battery by installing a Reversite breaker, and the battery can be depended to use its full strength to operate the signals.

The illustration shows a double pole Reversite circuit breaker with independently operating arms. The reversal feature is secured by the co-operation of two electro-magnetic systems; one consisting of a pivoted core and two pole pieces, depending for its excitation on a shunt coil, the terminals of which are subjected to the full voltage of the circuit; the second of two series coils. The pole pieces of the pivoted core normally stand just midway between the polar extensions of the cores of the series coils—supported from below by suitable stops, being free to move upward into engagement with the upper core and in so doing cause the opening of the switch arm of the breaker. When the current flows in the proper direction the pivoted core is pulled downward against the stops; while upon a reverse current flow it is drawn upward.

The operation of the Reversite breaker is dependent upon the co-operation of voltage and current, but the voltage alone will not cause the breaker to open. Even though the voltage falls considerably below normal the apparatus is still operative—the breaker can be closed on open circuit and the force tending to cause the opening of the Reversite breaker increases with the volume of the reverse currents. It depends for its operation solely on the occurrence of reverse current flow—obviously the operation of any safety device must depend entirely upon conditions prevailing in the circuit to be protected and not limited in its effectiveness by some independent circuit or appliance, the failure of which will render the device inoperative at the critical moment.



"Reversite" Circuit Breaker.

The overload feature of these breakers is capable of being adjusted of from 25 per cent below to 50 per cent above the normal rating. The Reversite feature is calibrated in amperes and is adjustable from 5 per cent to 25 per cent of the normal rating of the breaker.

GOULD STORAGE BATTERY CAR FOR PEKIN, ILL.

A new type of storage-battery car has recently been purchased by the Pekin City Railway, of Pekin, Ill., from the Gould Storage Battery Company, of New York City. This car is operated from the center of the city to the distilleries, a distance of about two miles, and up to the present time is reported to have given the best of satisfaction. It is in service about seventeen hours a day and from 100 to 110 miles are run on one charge.

The car has an overall length of 2 feet; the length of the platforms is 4 feet 6 inches, and the width of the car body is 7 feet 6 inches. The height from the rail to the top of the car body is 10 feet 4.5 inches. The seating capacity is twenty-eight. The car is propelled through single-reduction gears by means

of two series motors rated at thirty amperes, 110 volts. The controllers are of the series-parallel railway type.

The body is placed on a single truck of special design, combining lightness with strength. The car is lighted with tungsten lamps and provisions are also made for heating the car in cold weather. The battery equipment consists of 58 cells, 29 plate, Gould high-capacity batteries of the pasted type. These are placed in a special ventilated compartment under the longitudinal seats. The average speed with 8 stops of 8 seconds each per mile is 7 miles per hour.

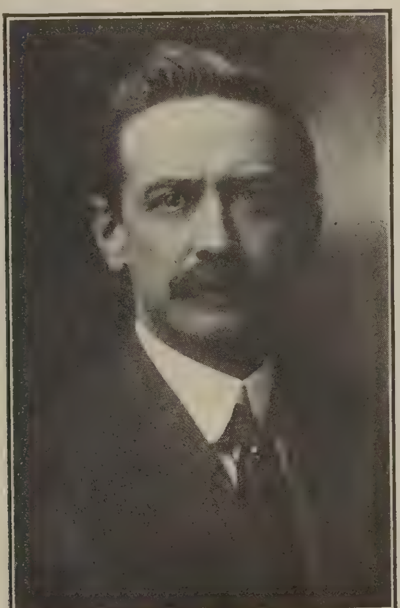
General News and Personal Mention

JAMES G. POMEROY.

James G. Pomeroy, for the past 17 years manager of the Chicago office of the Adams-Bagnall Elec. Co., has just been appointed sales manager of that company with headquarters in Cleveland, Ohio.

"Jim" Pomeroy is one of the pioneers in the electrical supply field, and his record as salesman and manager has been one of marked success.

Many of his friends were assembled at a farewell dinner given December 27th by the Electric Club of



J. G. Pomeroy.

Chicago in his honor, and the short reminiscent talks of some of those who have known Mr. Pomeroy for a long time bore the highest testimonial to a life of integrity and energy, such as few men ever attain.

He began his career in the electrical business with the old Electrical Supply Company of Chicago, in 1881. Three years later he became associated with the Brush Electric Company, and in 1894 joined forces with the Adams-Bagnall Electric Company.

Mr. Pomeroy was one of the organizers of the Electric Club of Chicago, serving as treasurer and as a member of the board of managers. He is an associate of the American Institute of Electrical Engineers, and statesman-at-large of the Sons of Jove.

NEW C & N W RY. TRAINS.

On December 17th, a new train, the North Coast limited, was placed in service on the Chicago Northwestern Ry. This train will run from Chicago to Seattle via. Chicago & Northwestern and Northern Pacific Rys. It is a solid Pullman train of eight cars, and the train lighting equipment is of the old Northern Pacific standard throughout. There is 110 volt, 25 k. w. 3,600 r.p.m. Curtiss turbo generator set with a 60 ampere hour battery on each car. These batteries are normally disconnected from the train line and each car is so wired that when the turbine is shut down at division points the battery is connected to the night circuit only.

Charging of batteries is all done in the day time when another switch is closed which connects the battery with the train line direct. Shortly after the first of the year this entire equipment will be changed from the 110 volt system using carbon lamps, to a 60 volt tungsten lamp system in accordance with the adoption of the new standard train lighting voltage by these two railroads. The dining car is equipped with a standard axle equipment, and the light circuit in this car is in no way connected with the through train line.

T. WILL JOHNSON APPOINTED GEN. MGR. PYLE NAT'L. ELEC. HEADLIGHT CO.

J. Will Johnson, sales agent of the Pyle National Electric Headlight Company, Chicago, was appointed general manager January 1, in charge of the sales department, with supervision of traveling representatives. Crawford P. McGinnis, air brake inspector Minneapolis, St. Paul & Sault Ste. Marie, and Robert L. Kilker, brother of general superintendent John E. Kilker, were appointed representatives. Mr. Johnson was born in Charleston, S. C., September 10, 1869. He started in January, 1886, in the freight department of the St. Louis & San Francisco, Pierce City, Mo., and was brakeman for one and a half years and fireman for two and a half years. In June, 1890, he was made locomotive engineer on the St. Louis & San Francisco, at Springfield, Mo. September 1, 1902, he entered the mechanical department of the Pyle company. In February, 1904, he was appointed special representative, and in September, 1908, he was appointed sales agent.

SOUTHERN PACIFIC CHANGE TO 60-VOLT SYSTEM.

All trains on the Southern Pacific line between New Orleans and San Francisco will in the future be operated at 60 volts. This includes the two new excess fare fast trains running between New Orleans and San Francisco.

In the past the 110-volt system turbine head-end sets have been used, but these will now be altered so as to operate at 60 volts. This change in no way affects the turbine element, the only changes necessary are the insertion of an additional variable resistance in the generator shunt field, and a heavy shunt across the compound field winding to diminish over compounding effect on heavy loads. This should be such as to maintain the same ratio between shunt field and series field magnetism as the generator was originally designed for.

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

SOUTHERN PACIFIC ELECTRIFICATION.

So little importance in the technical press has been given the progress of the electrification of Oakland, Berkeley and Alameda suburban lines of the Southern Pacific Co., that few realize the magnitude of the work that has been carried on.

The total cost of the first stages of this work, which is practically complete, is approximately $10,500,000. Ordinarily, in an undertaking of this magnitude, several prominent consulting engineers would be retained who would devote all or part of their time to the work to assure its successful installation. The Southern Pacific electrification, however, is unique in that the entire work of design, specification, purchasing and constructing was carried out wholly by the organization of the railroad company as it stood at the time the electrification was first authorized. The engineering force was, however, strengthened materially by procuring draftsmen and assistant engineers who had received their training in the larger electrification projects in the east. It is also significant that the cost of installation of each part of the work has never exceeded the original estimate by the engineering staff.

The Southern Pacific electrification is a most significant indication as to the future relation of present railroad management when railroad electrification becomes a reality.

Although there will be considerable change in methods and equipment, the operation of electrified railroads will be in the hands of present management. Electrification does not mean so radical a change as some are prone to think.

CAR LIGHTING IN EUROPE.

The paper on Electric Lighting of Railway Trains, by R. T. Smith, Electrical Engineer, Great Western Ry. of England, published in this issue, again emphasizes the importance of studying train lighting conditions in Europe. There will doubtless result much good and many valuable suggestions from a freer interchange of ideas and experience between American and European car lighting men. Accordingly the March meeting of the Car Lighting Club is to be given over to a discussion of Mr. Smith's paper, and to a comparison of English and American methods. Letters from various car lighting men will be read stating the equipment and train lighting methods on other English and continental railroads.

A. B. C. Car Lighting Series.

Few electrical men not directly associated with car lighting work appreciate in any way the complexity of the problems involved in electric lighting of railway trains. As a matter of fact, an axle equipment virtually involves the installation of a complete self-operated little central station on every car. This little central station must operate, moreover, under the worst conditions that can be conceived, that of greatly varying speed and intermittent source of motive power. The generator is placed directly on the car truck where dust, water, snow, ice and flying ballast all militate against the successful operation of the equipment.

So little attention has been given this subject in books and current publications, that we feel this series will meet a long felt want in this particular field.

In order that it be a comprehensive treatise of the subject and be of greatest value in giving car lighting men a better understanding of the problems involved, we bespeak your earnest co-operation in offering your frank criticisms and your suggestions. For this series of plain talks to be effective it must not only be of merit itself, but must be carefully studied by the men for whom it is written. So, in this we again must have your co-operation in calling the attention of the younger men in the car lighting field to the matter and suggesting that they get in line with this new series of talks which is being published in the RAILWAY ELECTRICAL ENGINEER.

Head End Train Lighting.

The remarkable development of axle generator systems in the past few years and a better understanding of methods of operation by the men in charge of the equipment has resulted in the axle system of car lighting being recognized as a thoroughly reliable and economical method of lighting passenger cars. Its many advantages over the head end system (flexibility, self operation, no terminal delays, much less drain on locomotive, etc.) have won it many enthusiastic advocates among railroad men; in fact, the majority of roads have abandoned the head end system and use axle equipments exclusively. It is, therefore, interesting to hear what one of the advocates of the head end system has to of-

fer in support of that system. Paper by C. R. Gilman on Head End Train Lighting before the Western Railway Club is published in this issue.

CAR LIGHTING CLUB.

The January meeting was an old fashioned Car Lighting Club meeting in every sense of the word. The subject of the evening, "Troubles and how to shoot 'em," brought out a line of discussion in which a large number of the practical "men on the job" participated.

Mr. G. B. Colgrove, I. C. R. R., opened the discussion saying that it was practically impossible to outline any definite course of procedure which would cover all cases of trouble, but that each particular case was a problem in itself. He said that they had experienced some difficulty with a regulator which seemed hard to locate until they examined the glycerine dash-pot. They found the glycerine frozen into a solid mass which prevented the regulator from operating and properly controlling the equipment.

Mr. S. W. Everett, Santa Fe, cited an instance which seemed to defy correction. The generator would leave the station in good order after a thorough test in the yard and on attaining critical train speed the automatic switch would close properly and the generator assume its load. All might go well for several minutes, when the generator would suddenly die and would not restore itself until leaving the next station, when the trouble would be repeated. In this instance it was found after a thorough examination that the trouble was due to a loose connection in the generator field, this incidentally being at the supposedly soldered joint between the field winding and flexible lead.

Mr. F. E. Hutchison, Rock Island, cited an instance where a noisy regulator was reported in the president's car. It was found to be due to regulator pounding. The belt was tightened and its pounding effect eliminated. Apparently the belt man was a little too strenuous in his efforts to remove the belt slip, for on the second trip a hot box developed which wore down the generator bearings to such an extent that the armature rubbed on the pole pieces was ultimately torn to pieces.

Mr. Hutchison wished to impress the importance of first locating the trouble by a series of tests before any radical steps were taken in dismantling the equipment. He said that for locating short circuits, a telephone receiver with magnetic interrupter combination could be advantageously used. He had experienced some difficulty with frozen glycerine to which Mr. Colgrove referred, but had eliminated it by mixing alcohol with the glycerine.

Mr. Everett said that with pure glycerine there should be no trouble experienced. He had, however, found a heavy oil similar to a tallow mixture used in some regulators which froze solid in cold weather.

Jess Younger, of the I. C., told of a very peculiar short circuit through a fixture and steel bell rope to ground.

Mr. Hutchison said that they had found some trouble with generators not picking up properly because of high mica. He said he believed that high mica is due more to the fact that mica is squeezed out between the commutator bars by expansion and contraction due to heat and cold, than to the actual wearing down of the commutator bars themselves.

Mr. Everett, of the Santa Fe, told of a system of reports which the Santa Fe used to keep car lighting troubles down to a minimum. When a car leaves Los Angeles a full report of the condition is made at the other end, stating exactly what was done to the equipment at that terminus. In addition to this, all men at division points in the trip to Chicago, report as to its condition, what was done, etc. The condition of the equipment on reaching Chicago is again noted on the card and these reports are all sent to the office of the Electrical Engineer. When any new and unusual trouble develops and in which the men have had no experience, the Electrical Engineer immediately advises all of his inspectors in regard to this trouble, giving them specific instructions as to where to look for it, how to remedy it, etc. Or when any particular car seems to be giving trouble the management can then advise their inspectors to look out for this car and as to just what trouble to look for. In this way it has been often times possible to anticipate trouble with car lighting equipment and correct it before the trouble itself really occurred. An instance of this was found in burnt out insulation of brush holders which caused the equipment to become grounded. They now look for this trouble in advance, replacing brush holder insulation before a burn out actually occurs.

Mr. Everett said that they had experienced no trouble whatever with field coils and he did not consider impregnation of coils as necessary.

Mr. John L. Ohmans, C. & W. I. R. R., submitted a question as to the cause of chronic burn-outs in automatic switch shunt coils.

Mr. Hutchinson said that it might be due to the fact that the automatic switch was set to operate at too high a point.

Mr. Younger said that there might be some melted copper globules on the face of the switch which would prevent proper contact.

Mr. Hutchison cited the Rock Island system of storage battery gravity records as an excellent means for finding trouble with axle equipments. Wherever a fall of 25 points in gravity occurred he invariably found some trouble with the equipment.

Mr. Everett said that the Santa Fe employed that system and found it most valuable as a check on the operation of the equipment.

In speaking of oils, Mr. Colgrove said that the I. C. used two grades. One for summer and the other for winter, but that even at that some trouble was experienced.

Mr. Everett was of the opinion that when oil once got properly into the bearings before the cold weather had a chance to freeze it, it did not make much difference if the oil in the well did freeze solid. There is usually enough oil on the bearings to last until the equipment warms up. He cited some instances where the oil was frozen solid enough to hold the oil ring in position when the armature was removed, but that no trouble whatsoever was experienced when the equipment was operated. There was one case of trouble, however, in which the generator was oiled for the first time in very cold weather. The oil did not have a chance to get into the bearings, but was frozen in the oil well so that a hot box developed before the oil ring warmed enough to free itself.

As to wiring, the Underwriters rules requiring that conduit be run to every light is generally adhered to. The wiring, however, is very often put in inexcessable places. It seemed to be the consensus of opinion that it was very bad practice to place conduit on the roof of the car.

The objections due to placing the conduit on the roof were inaccessability, leaky roofs, and deterioration of conduit. Uneven expansion of conduit and roof causes the roof joints to be forced open, causing leaks, etc.; the deterioration of conduit thus exposed on the roof is very great due to the combined corrosive effect of the

engine smoke and the severe abrasion of flying cinders from the engine.

Mr. J. Andreucetti, C. & N. W. Ry., said that the average life of conduit exposed on the roof was 2½ to 3 years, even though it was thoroughly painted every season. He said that the greatest weakening seemed to be where the strap holding the conduit in place was located. Accordingly they moved these straps every time the cars were painted in the shops.

One of the big difficulties of car wiring seemed to be lack of importance given it by the car departments and their consequent lack of co-operation. Mr. Cravens, however, pointed out the fact that a few years ago it was customary central station practice to build a power plant and then install the wiring and equipment to fit the building, while the present day practice is to design the generator units and switchboard first, then build the building around the equipment. He said a similar development would doubtless occur in the car building industry as it had with central stations.

Electric lighting is now considered, not as the mere luxury it was five years ago, but has now become an essential element in railway operation. The proper recognition of electrical departments has on some roads been already achieved but it is only a matter of a very short time before it will have a similar recognition on all roads.

Mr. Andreucetti said that the troubles of head-end systems were chiefly the bursting of hose, and lack of steam. Some trouble had been experienced in starting a turbine in a car that had previously stood unheated with the thermometer below zero. The steam on entering the turbine froze the blades together and it was with some difficulty that the turbine was finally started.

ASSOCIATION NEWS.

At the meeting of the executive committee in January, the various committee chairmen made progress reports which give an indication of a prosperous and even more successfull convention this year than last. The majority of the committees are holding monthly meetings, and by getting into the work early there should be some strong committee reports result.

Five applications for membership in the Association were passed as follows:

Wm. A. Delmar, New York City, N. Y.
C. E. F. Ahlm, Cleveland, Ohio.
W. H. Briggs, Evansville, Wis.
Wm. T. Griffin, Chicago, Ill.
A. E. Greenwald, Gibson, Ind.

NEXT MEETING OF CAR LIGHTING CLUB.

The next meeting of the Car Lighting Club will be Ladies' Night, and an informal dance will be held in the library of the Western Society of Engineers. This is located on the top floor of the Monadnock Bldg., corner Jackson and Dearborn. The night entrance, however, is on Dearborn street, all other entrances being closed after 7 o'clock.

We have chartered Sousa's Band and have kidnapped Rector's chef to take charge of the eats on this festive occasion, so bring your lady-love and we will all trip the light fantastic till some time the day after.

Dad Farrelly and Grandpa Gilman will probably break into the jollification with a discussion on the relative merits of Guernseys and Holsteins as butter factories, but it will take more than that to put on the soft pedal.

Oh, by the way, the treasurer pays the fiddler, so mark your calendar and be on deck 8:30 P. M., Wednesday evening, February 21st, top floor, Monadnock Building, north entrance on Dearborn Street.

The subject of the March meeting of the club will be Train Lighting in Europe, and we will discuss the paper on Electric Lighting of Railway Trains by Mr. R. T. Smith, electrical engineer of the Great Western of England, part of which is published in this issue.

This meeting of the club has been extensively advertised in Europe by our worthy secretary, and it is understood that we will have letters from numerous other European and continental car lighting men giving us a line on their equipment and their methods of car lighting. This ought to be one of the best meetings on record, for we will have a chance to see what the other fellow across the water is doing and how he does it. Better read over Mr. Smith's paper in both February and March issues carefully before the meeting and come loaded for bear.

The arrangement committee announces also the following subjects:

April, "Planning and Equipping of Railroad Shops." By George W. Cravens.

May, "More Troubles." Discussion opened by H. G. Meyers.

The January meeting on troubles was so successful that it was decided to repeat the program and bring out some more helpful ideas.

Head End Electric Train Lighting

By C. R. GILMAN, Chief Electrician C., M. & St. P. Ry.*

Not since Mr. Ott gave us his valuable paper on this important subject in April, 1907, has there been much written or much discussion on head end train lighting before this Club.

The business has not stood still, however, but has steadily advanced, and while it is still an open question which system best meets railway conditions, head end lighting is taking a more important place today than it ever has before in the railway world, and I believe will continue to hold its place in electric lighting of cars for a long time to come.

While the general system of head end train lighting is the same as used 15 years ago, there have been a number of improvements and changes made. These, with the adoption of the new types of electric lamps, storage batteries, fixtures and reflector glassware, makes this system very efficient and reliable, where first-class uniform lighting is required on a heavy train.

While some of you are acquainted with the method of operation of a head end lighted train, a short description is thought necessary to enable others to better follow the paper. A head end system is one where a steam turbine driven dynamo is placed either on the locomotive or in the baggage car, taking steam from the locomotive to operate it. Auxiliary lighting is maintained, when locomotives are changed or cars stand in terminals, by two, three or four storage batteries, depending on the number of cars in train. These batteries float on the

*Paper presented before Western Railway Club, January 1912.

main train wires in parallel with the dynamo, lighting the lamps should any thing happen to dynamo, turbine, steam hose or train part and pull out a connector. Fig. 1 shows general wiring diagram.

One of the advantages of the head end system is that the size of a train that can be lighted by this system is limited only by the number of cars the present locomotive can haul. I am, therefore going to take a 17 mixed car train as an example.

Equipment.

One 25 kw. Curtis tubo generator, 3600 R.P.M. 110-125 volts.

Switch board and dynamo connection in baggage car.

Automatic loop connectors.

Standard 2-compartment sets of train lighting batteries.

The train is made up as follows:

1 dynamo baggage car	14 lamps
2 mail cars	66 lamps
1 mail tender	8 lamps
1 Comp. sleeper	60 lamps
1 12 section sleeper	80 lamps
1 buffet car	82 lamps
5 12 section sleepers	400 lamps
1 dining car	42 lamps
1 parlor car	42 lamps
3 coaches	78 lamps
17 cars	872 lamps

at full capacity twice a month they remained in good condition.

Early in 1910 I went seriously into the subject of charging batteries on the trains, as our charging plants are small and the number of batteries to charge continually on the increase. Charging batteries enroute requires plenty of current, lamp regulation and means to determine the amount of charge and discharge the batteries are receiving.

While there are a number of very good automatic lamp regulators on the market, they are quite expensive and each car on the train has to have one. Owing to the large number of cars required to make up this train, the cost of automatic regulators would have been over $1,700, and we cast about to see if we could not substitute some means to accomplish the desired results at less expense. This has been accomplished without altering or adding to the present three wire standard by connecting the battery directly across the dynamo leads instead of between the dynamo positive and return loop negative as customary, and placing a hand operated resistance between the forward end of the return loop and the dynamo negative lead, in baggage car. This lamp resistance is brought into use by opening the connector loop in rear of train and closing it on switch in baggage car. Fig. 1.

On account of the high steam pressure needed to operate the dynamo, the baggage car is run next to the locomotive. On this train there are three mail cars without end doors between it and the train. Our baggagemen therefore, cannot get into the train while it is in

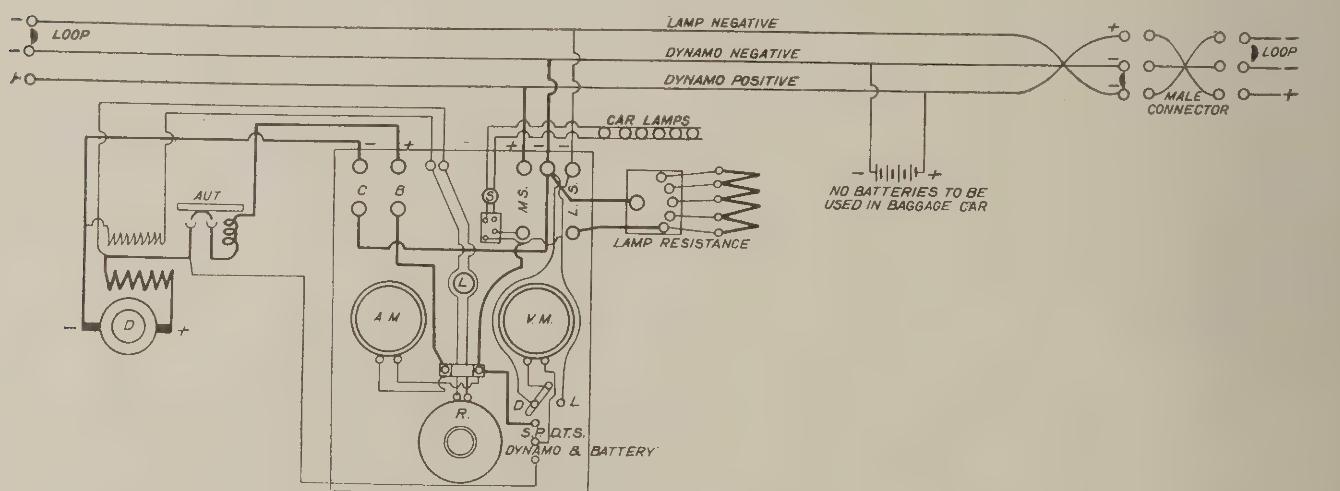


Fig. 1—Diagram Showing Battery Charging System.

Eight hundred and seventy-two 104 volt 8 c.p. lamps are used and the total lamp load is 20,627 watts. The losses in machine and train lines is 22 per cent so the load on dynamo is 25,219 watts, which is the full capacity of the machine.

In actual operation we seldom get continual steam pressure enough to operate this load, so allow the storage batteries to help out until the number of lights is reduced, as passengers retire for the night.

Previous to April, 1910, we connected our batteries in parallel with the lamps on the two outside mains, allowing them to float on the lamp system. Later when the sleeper passengers had retired and the load was largely reduced we raised the dynamo voltage to 118 or 120 and gave the batteries what is known as a floating charge. One hundred and twenty (120) volts is not high enough to properly charge the batteries but was as high as we deemed advisable to run our lamps. We found, however, that the batteries took a fairly good charge at 120 volts and with an initial charge in the yard

motion and as they operate the electric lighting, it is very necessary for them to have simple rules to run by. I will therefore quote our charging instructions as they fully explain the operation of charging the batteries.

Instructions to Dynamo-Baggagemen.

At about midnight or when lamp load has fallen to the minimum begin charging.

Arrange previously with rear-brakeman to open rear connector loop.

Better arrange to do this at some station. Just before arriving at this station throw in your front end loop, otherwise train will be in darkness as soon as rear loop is opened.

Now, with everything running as it should be, put volt meter switch on lamps, throw in first point of large lamp resistance. That will lower voltage, raise lamp voltage to 104. Now read dynamo voltage, if it stands at about 128 or 130 let it alone; if not, throw large resistance to No. 2 and again raise lamp voltage to 104. Continue this until

you have about 104 volts on lamps and 128 to 130 volts on dynamo. Let it run now until ampere load has fallen to about 5 to 10 amperes for each battery back of your car in addition to the lamp load. Then shut down dynamo. Pay particular attention to the amount of steam necessary to operate the dynamo and call for as little as possible. This is very important. It saves coal, saves steam for the locomotive (where it is sometimes badly needed) on the road, and keeps the batteries in good condition.

The controlling of the charge is done by having ampere hour meters in circuit with each battery. These are read at terminals and baggage men advised to charge more or less as the conditions demand.

Lighting a 17-car train having over 800 lamps, and being about a quarter of a mile long is no mean undertaking, and on account of the heavy all night load (75)

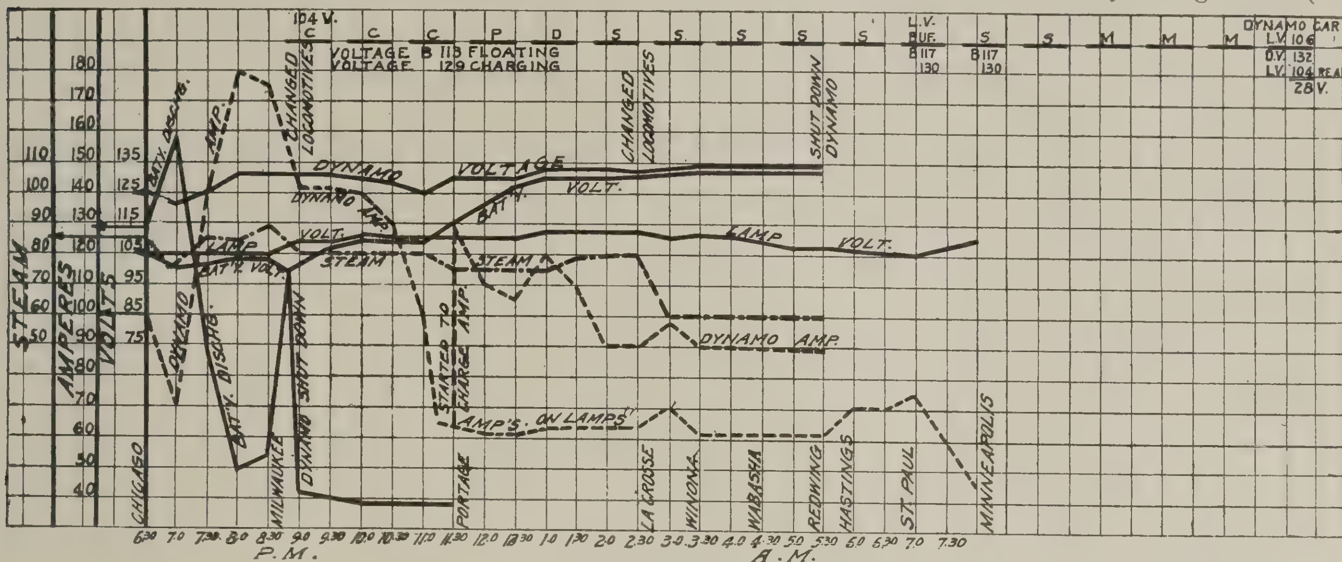


Fig. 2—Test of 110 Volt System.

and saves bursting steam hose, an expense to the company, delay to the train, and trouble to yourselves.

Page 227 shows an automatic loop connector to open the loop, it is only necessary to insert the male connector. Therefore, if all connectors are in place there are no loops in the train except the one on rear of last car. Should train part from accident or is parted for switching, as soon as male connector is taken down the automatic loops immediately set, forming a circuit for

seventy-five amperes it was found hard to keep the batteries charged and give satisfactory illumination. I therefore suggested to our people that we reduce the load on this train by adopting 60 volts, and using tungsten and tantalum lamps.

Many of you are aware that for more than two years I have been a strong believer and an earnest worker in endeavoring to bring about a standard of 60 volts on all the head end lighted roads, and while most electrical men can see advantage in it, the mechanical people

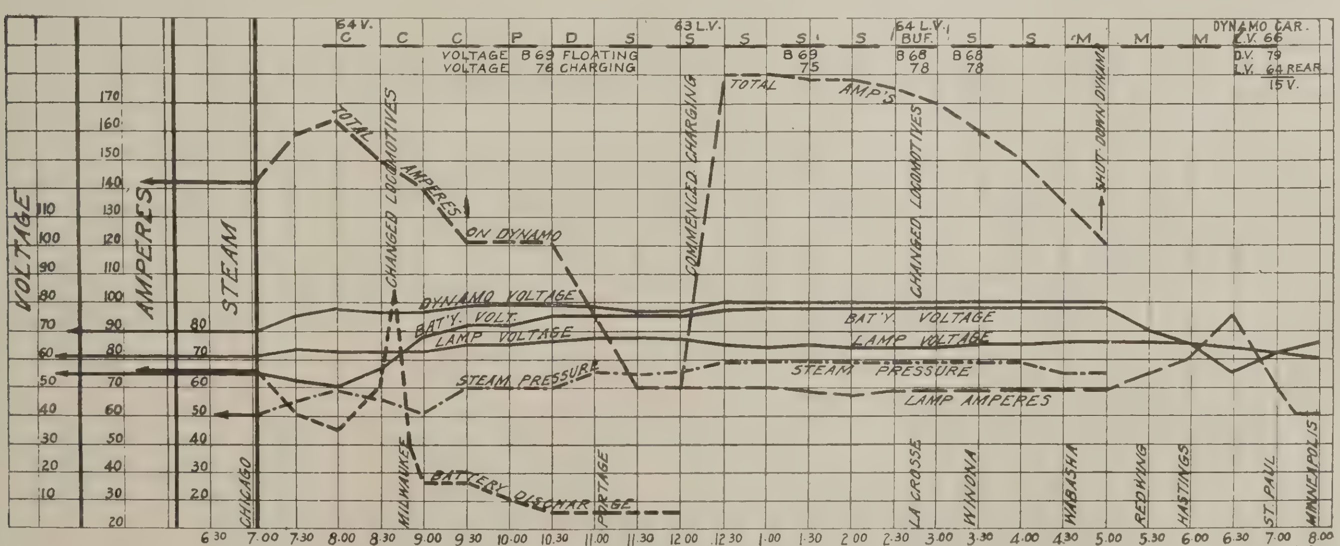


Fig. 3—Test of 60 Volt System.

the current, either from the dynamo in front, or battery on last part of train.

The total cost of equipping a train for this system is $67.50. This includes hand lamp resistance, automatic cut out and extra main car feeders brought from roof main down to switch box and connections made in 4-battery cars.

This system of charging has cut down the lamp renewals 30 per cent, has enabled us to do our charging

on some roads have so far not taken it very seriously. It gave me great satisfaction, therefore, that our people allowed me to try it out on the Pioneer Limited.

On November 10, 1910, this train arrived in the yard at 11:00 A. M., 110 volts, and when it left at 5:30 P. M. had been changed to 60 volts, lamped and tested. The operation that night was all that was expected and the lighting was beyond reproach.

To convert the 110 volt dynamo into a 60 volt ma-

chine, we placed an extra field rheostat in series with the old one and a shunt across the compound field terminals. I had previously tested out a number of these generators and knew just what to do with them. The cost of converting this machine from 110 to 60 volts was $7.50.

Figure 3 is a test sheet of this train at 64 volts.

You will note by comparing it with test No. 2 of 104 volt train that the amount of steam required to operate dynamo averaged about 18 pounds less. That the battery charging current available was 50 per cent greater. The voltage was more uniform, 12 C.P. lamps were used instead of 8 C.P., increasing the light on train 50 per cent.

Now let us compare the operation costs of the two systems.

As there are six items that differ in each train operation, we will compare them only.

Consumption of steam.
Weight hauled.
Battery depreciation.
Lamp renewals.
Yard labor.
Total candle power.

110 VOLT TRAIN.

Steam Consumption.

We find that on a 110 volt train the average load was 14.96 kw.

Taking tests made by Mr. Wray, Bulletin No. 268, University of Wisconsin, for the efficiency of the turbine, we find that at 15 kw. load 88 lbs. of steam was used per kw.h. 88x15 kw. equals 1320x19 hours per trip equals 25080 lbs. steam used. This divided by 5:5 lbs. water evaporated per lb. of coal equals 4560 lbs. as used per trip 182 trips per year equals 829920 lbs. coal divided by 2000 (lbs. per ton) equals 415 tons multiplied by $2.00 equals $830.00, cost of coal per year.

Cost of Hauling Batteries.

Four sets of 54 cells each, 216 cells at 173 lbs. each equals 37,368 lbs. divided by 2,000 (lbs. per ton) equals 18.68 tons, 820 miles per trip multiplied by 182 trips multiplied by 18.68 equals 2,787,803 ton miles multiplied by .0015 cents per ton mile equals $4,181.70.

Battery Depreciation.

Battery depreciation figured at 15 per cent...$679.40
Yard labor 554.80

Lamp Renewals.

Carbon lamps cost 20 cents each, 5,232 lamps were used, which equals $1,046.40.

60 VOLT TRAIN.

Steam Consumption.

The average load is 10 kw., the average steam used is 105 lbs. per kw.h.

Figured in the same as for the 110 volt train the cost of coal for this train was $660.00.

Cost of Hauling Batteries.

Four sets of 32 cells each 128 cells at 173 lbs. equals 22,144 lbs. or 11 tons equals $2,503.80.

Battery Depreciation.

Battery depreciation at 15 per cent $403.20.

Yard Labor.

While there are 40 per cent less batteries to handle the other work on the train remains the same, so I have taken 65 per cent of the yard cost of the 110 volt train which amounts to $360.12.

Lamp Renewals.

Forty-seven cents each is average cost of tungsten and tantalum lamps. We have figured 10 per cent more lamps used than on the 110 volt train. Cost of lamps $2,704.85.

Table of Costs, 110 Volt Train.

Coal for operating dynamo..........	$830.00
Batteries, cost of hauling............	4,181.70
Battery depreciation 15 per cent......	679.40
Yard labor	554.80
Lamp renewals	1,046.40
	$7,292.30

Table of Costs, 60 Volt Train.

Coal for operating dynamo..........	$660.00
Batteries, cost of hauling............	2,503.80
Battery depreciation	403.20
Yard labor	360.12
Lamp renewals	2,704.85
	$6,631.97
Total saving by 60 volt system.......	$660.33
Total C.P. 110 volt train............	6976
Total C.P. 60 volt train............	10,464

While the difference in operating expense is not great, the lighting service is 100 per cent better. In fact, our operating troubles have been so greatly reduced, that where we formerly received constant reports of poor lighting, we seldom if ever now get a report of that kind.

Closing, I wish to say that the interchange of cars, on our western roads is on the increase, and a uniform voltage for the head end lighted trains is more than ever necessary, and I hope the day is close at hand when those roads that have not adopted the 60 volt system as standard will soon see their way clear to do so.

Indirect Illumination

On Private Car of B. F. Yoakum Chairman of Board of Directors of Frisco Lines

In the January issue we described a system of attempted indirect lighting on the new Santa Fe De Luxe diners, which, as far as indirect lighting goes, is in no way successful, so it is gratifying to be able to describe another car more correctly designed in so early an issue. This car, which contains the first effective system of lighting passenger cars by the indirect system, serves as the private car of Mr. B. F. Yoakum, Chairman of the Board of Directors of the Frisco Lines, and was placed in service in November, 1911. It was built at St. Charles, Mo., by the American Car & Foundry Company, and the lighting fixtures were designed and built by the Safety Car Heating and Lighting Company of New York.

It is obvious that the dimensions of a railway car do not make the most ideal conditions for indirect lighting. The low ceilings and the customary mahogany panels and trim in the car prevent the most ideal illuminating results. It will, however, be seen from the accompanying tables, showing the illumination obtained by this method of lighting on this car, that the results obtained are very satisfactory. The fixtures used were not distinctly of the indirect lighting type, although in one of the lamps no useful light passes through the glass bowl of the fixture. The interior views of the dining and observation rooms on this car shown herewith, give a very good idea of the design of the fixtures used. In the dining room the bowl

of the fixture is made of leaded glass. The glass is of such a density as to permit of sufficient illumination of the color design, but does not allow any useful light to pass through. The bowl is mounted to the metal band, which is supported from the ceiling by cast bronze chains.

The design of the fixture, of course, was governed to a considerable degree by the requirements of car service. Sufficient strength was necessary to not only support the band and bowl, but also to insure against violent thrust of the fixture resulting from sudden jolts of the car. It will be seen from the illustrations that the convergent arms or chains produce a pleasing effect while sufficiently far apart at their base or ceiling to give ample strength. Diverging arms or solid chains would increase the strength, but their appearance would detract from the fixture. The fixture in the observation room is identical with that in the dining room, excepting the bowl. The bowl of this fixture is made of leaded glass of greater translucency than the glass used in the dining room bowl, in order that some useful direct illumination be available.

The arrangement of the lamps and reflectors in these fixtures is somewhat unusual. Mounted at regular intervals inside the bronze band are twelve porcelain receptacles, using tungsten lamps. The lamps are held in a horizontal position so that the maximum light is thrown on the ceiling directly and by reflection. The reflector consists of a polished nickel flat circular band placed directly under the lamps and of sufficient width to intercept the maximum downward flux of light. The tip candle power of a tungsten lamp is very small, but is enough to throw light enough across the bowl to illuminate that portion of the glass diametrically opposite from the lamp. By this method of lighting the glass bowl, shadows are avoided and a surprisingly even distribution of light is obtained at every part of the bowl.

It might be well to note that, owing to the dimensions of the room, it was found desirable to raise the tips of the three lamps on each side of the fixture towards the ends of the rooms. This was done in order to obtain a wider angle of incidence and reflection to re-direct more light to the ends of the room. These fixtures are unusually large in comparison to what has been used heretofore in railway cars, and considered alone would be too large for the confined area of these rooms. This fact, however, was duly considered when designing the fixtures, and since the finish of the rooms is severely plain, each fixture becomes the central figure in the decorative design of the rooms.

To appreciate more clearly the conditions governing the illumination of these two rooms, it might be well to say that the ceiling in the dining room is chalk white, the ceiling in the observation room ivory or

Fig. 1—Indirect Illumination in Dining Room.

cream white. The side walls, panels, etc., in both rooms are light mahogany. The carpet is dark green. The metal portion of the fixtures is finished in verde antique.

By comparing the illumination obtained from these fixtures in both rooms with the table of desirable illuminations compiled by Barrows, it will be seen the light is ample in both rooms. The illumination readings were made with a Sharp-Millar illuminometer three feet above the floor, with the car furnishings exactly as used in service. The results of these readings, however, are not the only conclusive evidence of the good illumination. Casual observation as well as an extended observation of the light by the occupant of either of these rooms produces a pleasing effect. Where more illumination is required than that obtained by the indirect lighting fixtures, provision has been made by the use of four direct lighting lamps in each room, underweath the lower deck. The design of this fixture is illustrated in connection with this article and also a table lamp used in the observation room.

Illumination in Dining Room—Center Fixture Using Twelve 15 Watt Tungsten Lamps the Only Source of Light.

Station.	Foot Candles.
1	1.60
2	2.02
3	2.20
4	2.20
5	1.68
6	1.82
7	2.50
8	2.20
9	2.50
10	2.55

Average 2.06 foot candles.

Illumination in Dining Room—Center Fixture Using Twelve 25 Watt Tungsten Lamps the Only Source of Light.

Station.	Foot Candles.
1	1.81
2	2,30
3	2.68
4	2.70
5	1.88
6	2.10
7	2.95
8	3.00
9	3.40
10	3.00

Average 2.48 foot candles.

Fig. 2—Indirect Lighting Fixture in Observation Room.

Illumination in Observation Room—Center Fixture Using Twelve 15 Watt Tungsten Lamps the Only Source of Light.

Station.	Foot Candles.
1	2.26
2	3.20
3	3.60
4	3.40
5	1.96
6	2.43
7	4.20
8	6.40

9	4.62
10	2.70

Average 3.28 foot candles.

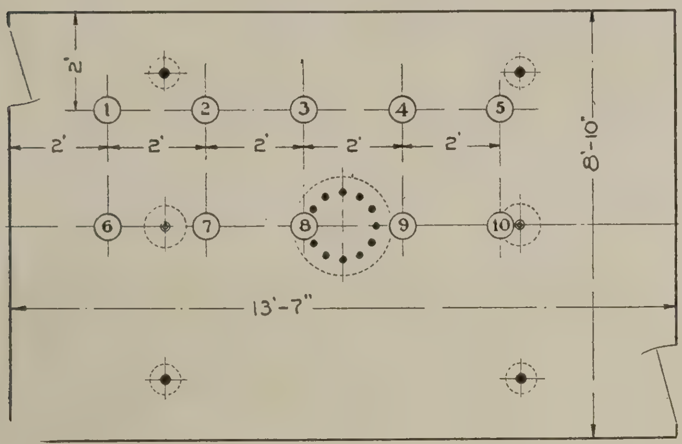


Fig. 3. Diagram of Test in Dining Room.

Library	General illumination	1	to 2
	Reading tables	3	to 4
Ball rooms		2	to 3

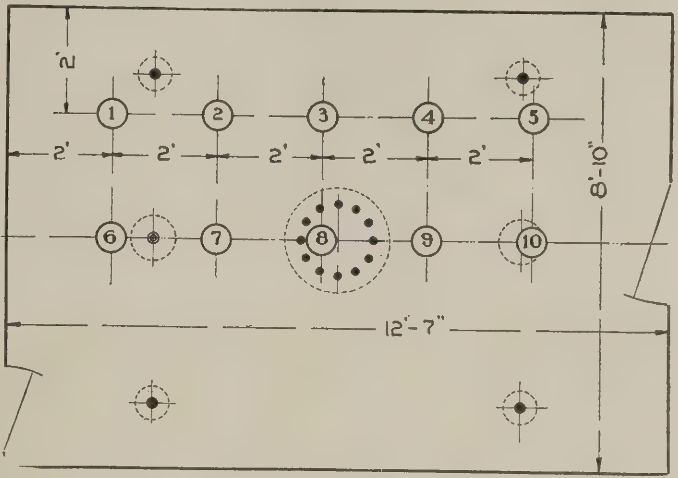


Fig. 4. Diagram of Test in Observation Room.

Lighting Requirements in Foot Candles for Various Services as Compiled by Barrows.

Assembly rooms, corridors, public spaces		.5	to 1.5
Auditoriums, theaters		1	to 3
General illumination of residences		1	to 2
	Good clear print	1	to 1.5
Reading	Newspaper print	2	to 2.5
	Postal service	2	to 4
Churches		2	to 4
Desk lighting		2	to 5
General illumination of stores		2	to 5
Bookkeeping and clerical work		3	to 5
Clothing stores		4	to 7
Display of dark goods		5	to 10
Drafting, engraving		5	to 10
Street lighting by gas		0.05	to 0.25
Street lighting by electricity		0.05	to 0.50
Light from full moon		0.025	to 0.03

Electric Lighting of Railway Trains in England

By ROGER T. SMITH, Electical Engineer, Great Western Ry. of England*

The subject for the February meeting of the Institution of Civil Engineers of England will be "Electric Lighting of Railway Trains by the Brake-Vehicle Method." We have just been given permission to publish an abstract of this paper by the Institute.

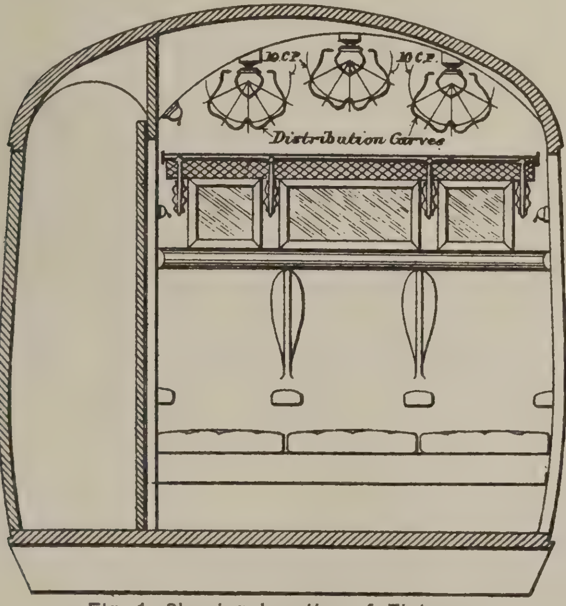


Fig. 1—Showing Location of Fixtures.

Mr. Smith's paper is a very comprehensive one, and, although conditions are radically different in England, there is much information contained in his paper which will be of interest and value to car lighting men in this country.

The method of train lighting considered in this paper is that in use on the Great Western Railway, where axle-driven dynamos and accumulators, controlled by an automatic regulator, are installed on some of the coaches only. The lamps throughout the train are supplied from these equipments, which all work in parallel, similar to central station practice. In general, apparatus and batteries are installed on brake-vehicles only, several other coaches being supplied from them under complete automatic control as to voltage. There is a consequent appreciable reduction in the initial cost and in the cost of upkeep of the equipment.

The author then gives an historical sketch of the development of axle-driven car lighting equipment in England extending back as far as 1883, when Wm. Stroudley placed the first axle lighting equipment on the London, Brighton and South Coast Railway. In this equipment there was one generator placed in the guards-van, or baggage car, which supplied the light for the entire train. This experimental equipment was so successful that more trains were rapidly equipped with this system. The guards-van system, or headend axle equipment, as it would be known in this country, was subsequently replaced, however, by the Stone system, patented by Mr. A. B. Gill in 1894 and improved in 1896, in which a generator and two sets of storage batteries are placed in each car.

In 1884 the London & Northwestern Railway employed a steam driven dynamo placed on the back of the tender for lighting a block train, no battery auxil-

*Paper presented before Institution of Civil Engineers, London, England, Feb. 1912 by Roger F. Smith, Elec. Engr., Great Western Ry. of England.

iary being supplied. The headend steam-driven system, however, has subsequently been entirely supplanted in England by various axle-driven devices.

Car Illumination.

The author says that to people with good eyesight and illumination of one foot candle falling on a pink newspaper (which may reflect only 40% of the light) may be sufficient, but after considerable experimentation the author is of the opinion that the illumination on a horizontal plane at eye level about 4 ft. from the floor should never be less than 1½ ft. candle. In all modern passenger cars he aims to provide an illumination of 2 ft. candle on a horizontal plane for third-class cars and 2½ ft. candles for first-class coaches.

An important element in glare is contrast between the source of light and its surroundings. The intrinsic brilliancy of a candle flame is but 3 candles per sq. in., but when this is seen in an otherwise dark room against a black background it causes discomfort. When a large sheet of white paper is placed behind it, however, so that the flame is seen against an illuminated background, the discomforture is very much reduced.

Adapting this principle to railway car lighting, the author provides that car ceilings be painted white. This has the double effect of increasing the effective illumination at eye level and increasing one's ability to see by the elimination of strong contrast.

Glare due to high intrinsic brilliancy can be diminished, if not largely prevented, by providing a white enameled background so that the filament, when seen, is always on a brightly illuminated surface.

In first-class coaches diffusion globes known as the short-pine holophane globes are used to get proper distribution of light. In third-class coaches these are omitted.

Lamps.

The author says that the majority of electric-lighted trains at present in use in England were designed to use carbon filament lamps 8 to 10 candle power, requiring 3 to 5 watts per mean horizontal candle power. The tungsten train lighting lamps used in England require from 1.2 to 1.5 watts per mean horizontal candle power. As the result of a series of tests carried out by the National Physical Laboratory, it was decided the most satisfactory energy rating of tungsten lamps for train lighting is 1.3 watts per candle, giving useful life for about 850 hours, against 600 hours for the carbon lamp with an efficiency of 3¼ watts per candle. The tungsten lamp under these conditions in England costs the same as the carbon lamp, and gives the same light for the same time at 40% of the energy consumption required by the carbon lamp. In actual service the author says the tungsten train lighting lamps have given an average of 900 hrs. on the Great Western Railway.

The arrangement of electric lamp fittings adopted after considerable amount of experiment for modern first-class cars is shown in Fig. 1. The ceiling is painted dead white, which improves the general illumination and prevents glare. The author says that any lighting system which provides a dark unilluminated ceiling is bad, and he objects seriously to the use of reading lamps in a compartment.

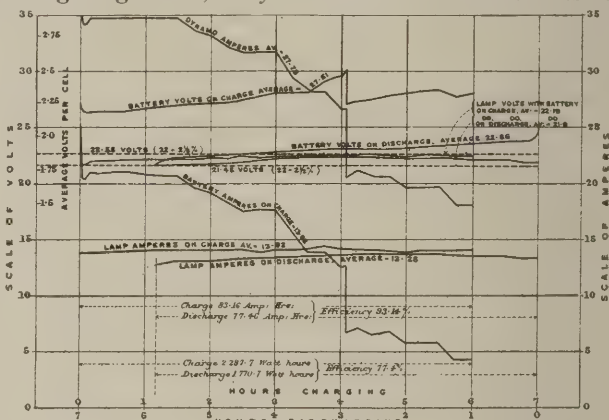
In the author's arrangement each first-class compartment has five 10-candle power lamps enclosed in pine shaped holophane globes. A dimming switch reduces the illumination to about 1/40 foot candle, this being required by the Board of Trade so that the lights in a passenger car will never be entirely extinguished. One of the advantages quoted by the author in lamps inside diffusing globes is that it prevents theft and breakage by car cleaners.

Dining cars are expected to be somewhat better lighted, but the author believes that a plain short stalk or batten fitting, placing the lamps in holophane globes directly under a white roof, with a lamp above each table, gives the best effect.

As to voltage regulation, the author said that this must be kept within 2½% above or below normal. Even this variation will result in an increase in candle power of 10% and a decrease of 8% with tungsten lamps, and an increase of 15%, with a decrease of 14% with carbon lamps. Twenty-two-volt lamps are used generally on the Great Western Railway, as it is a direct multiple of the standard voltage of 110, 220, etc., and it always permits of using 12 lead cells for batteries, a very convenient number.

Storage Battery.

The author believes that in order to draw proper attention to the importance of storage batteries in train lighting work, they should be considered as the



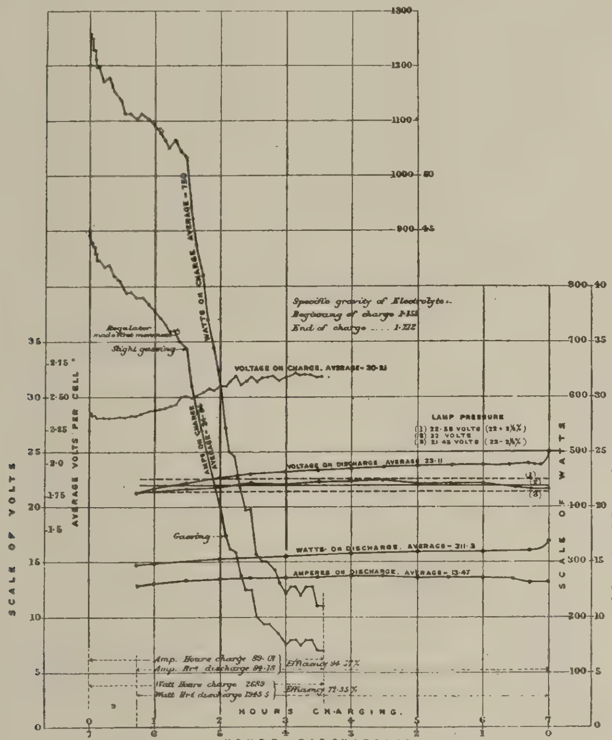
90-AMPERE-HOUR BATTERY CONTROLLED BY LEITNER REGULATOR: NORMAL SETTING

Fig. 2.

essential element and the dynamo merely a device for providing that the output of the batteries be continuous through the hours of lighting. The author says that, although the voltage of the storage battery is not an accurate indication of its condition of charge, it may be generally said that when that voltage reaches 2½ volts per cell the battery is fully charged. It is quite practicable then, when this point is reached, to cause the charging to cease or to reduce it to a lower value. He believes this to be of considerable service in train lighting work. On the other hand, it is not at all practical to limit the discharge of the battery to 1.8, for in case of failure of the generator, the cells must supply light as long as possible, even though of low value. The author says that on his road they have employed both constant voltage and constant current methods of charging batteries. Between these two extremes—charge at constant current with rising voltage and charge at constant voltage with falling current—there may be, of course, an infinite number of gradations.

The efficiency of charge with current at constant voltage is greater than at constant current. This is well known, and forms one of the attractions of the constant-voltage method. In general it may be said that the filling-up of the battery quickly at the start and rapid tailing-off of the current near the end is good for the lead cell. The great practical difficulty in the method is the excessive current taken during the first ½ hour.

Careful experiment has shown that for any train-service other than a slow stopping service the full-load output of the dynamo in amperes at maximum voltage should be between one-and-a-half times and twice the amperes taken by the lamps, and that the mimimum capacity of the battery should be equal to



90-AMPERE-HOUR BATTERY CONTROLLED BY LEITNER REGULATOR: SET TO APPROXIMATE TO CONSTANT VOLTAGE.

Fig. 3.

the full-load output of the dynamo for 3 hours. This does not mean that the battery is to give this output at the 3-hour rate, but that the dynamo-output multiplied by three gives the capacity at the 8-hour rate. That is to say, with a lamp-load of 15 amperes and a dynamo capable of an output of 30 amperes at full load, the battery-capacity at the 8-hour rate must be not less than 90 ampere-hours. With a sufficient pres-

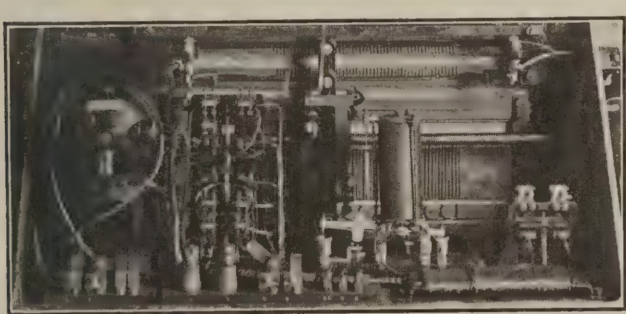


Fig. 4—Leitner Regulator.

sure to charge the minimum size of battery fully with a constant voltage of only 2:32 volts per cell, the proper size of dynamo according to this rule would actually be overloaded 50 per cent. for ½ hour. This is on the assumption that the lamps are not burning during the maximum rate of charging; if the lamp-load is added, the overload of the dynamo during ½ hour would be 100 per cent. Such an overload is not admissible, so that the dynamo must be appreciably larger with constant-voltage charging than has been found needful where other methods are in use, and it will consequently run during most of its output at a poor efficiency. This would not be a serious matter if 2:32 volts per cell were sufficient to keep the battery in health; but it is not sufficient, for two reasons. During the process of charge the specific gravity of the acid slowly increases to a maximum. During the early part of the charge, when no free gas is evolved from the plates, the heavier electrolyte tends to collect at the bottom and there is a regular gradation of layers of increasing density from the top downwards. When the cell is nearing the end of its charge, gas is given off in bubbles from both plates. As soon as gas is given off freely, it serves a very useful purpose in circulating the electrolyte and mixing the layers of different density, so as to help natural diffusion. But with only 2:32 volts per cell sufficient gassing cannot be obtained, and the constant voltage has to be raised at least to 2:5 in order to obtain free gassing at the end of the charge. This means a still larger rush of current during the first ½ hour and a correspondingly larger dynamo. Secondly, to cure the initial stages of sulphation, which is the disease to which all lead cells are subject when insoluble lead sulphate chokes the pores of the active material, a charge up to 2:75 volts per cell is necessary, and no train-lighting equipment can be said to look after the battery properly unless it permits of a simple adjustment by which the voltage at the end of the charge rises to 2:75 volts per cell and stops there with a small current passing through the cells.

On the other hand, charging at constant current produces at the end of the charge such violent gassing at both plates that the active material is torn off and wasted in the bottom of the containing box from which the gradual accumulations have to be cleared out before they reach to and short-circuit the ends of the plates. Some over-charging is necessary for the health of the cell, chiefly to stir up the electrolyte mechanically by gassing and partly to get rid of the insoluble sulphate of lead referred to; but this over-charging must be under complete control, and the Author is not aware that any constant-voltage system provides for it. Although, for axle equipments requiring dynamos of small size, constant-voltage charging at 2:5 volts per cell is being run successfully today, while the jolting a battery receives under a coach may help to make up for the want of gassing when voltages under 2:5 per cell are employed, constant voltage hardly appears feasible for dynamos with a normal output of 100 amperes.

It is fortunately quite possible, by making the voltage rise gradually throughout the charge, and thus prevent the enormous rush of current at the start, to obtain the chief advantages of constant-voltage charging, namely, the steady reduction of the charging current technically spoken of as "tailing" the charge, and at the same time to insure such a voltage at the end of the charge that the cells gas freely.

Curves of a similar twelve-cell train-lighting battery of 90-ampere-hour capacity, but controlled by means of an automatic regulator, are given in Fig. 2. Charging is effected with a dynamo having a maximum output of 45 amperes, and controlled by the automatic regulator, which gradually raises its voltage, though not fast enough to charge at constant current. After 4 hours of charging with a final pressure of 2:5 volts per cell, the regulator cut off half the dynamo-field, the drop in charging current being clearly seen, and during the next 2 hours it brought down the charging current to 4 amperes. In Fig. 3 are shown curves for the same equipment with the regulator set to give

a maximum voltage of 2:65 per cell for rapid charge for desulphation, the shape of the current-curve approaching to a constant-voltage charging-curve. Gassing began after 1½ hour charging owing to the high voltage, and both plates were gassing freely after 2 hours charging, Tests of samples of acid drawn from various depths in the cell showed no difference in specific gravity between the top and bottom of the cell, whereas when the battery charged at constant voltage at 2:32 volts per cell a difference in densiy of 4 per cent. between the top and bottom when fully charged was obtained. No doubt if the constant voltage had been 2:5 volts per cell there would have been sufficient gassing to prevent this. In both Figs. 2 and 3 it will be seen that the part of the regulator which looks after the lamp voltage kept this voltage throughout both charge and discharge within $\times$ 2½ per cent.

These diagrams of tests of actual train-lighting equipments show that apparatus can be provided which will properly look after the charging of the battery. In the actual apparatus experimented with, in addition to the provision referred to for cutting off half the field of the dynamo, resistance is automatically inserted in the other half of the dynamo-field when any predetermined voltage for which the regulator may be set is reached. This, while still keeping a very small exciting current, cuts down the output from 50 to 99 per cent., and finally leaves the battery floating on the dynamo as soon as it is fully charged. These are ideal conditions for the health of lead cells, and batteries opened out after 12 months' use under these conditions have proved to be in perfect condition.

If machinery can be provided which automatically looks after the charging of the battery, securing that under all but accidental conditions, it is fully charged until both plates gas freely, and that then the charge is either cut off or so reduced as to leave the battery floating, all has been done that automatic apparatus can be expected to do. Human skill and organization must do the rest to keep the cells in health.

At the present time the active material in the lead cell seems limited to a life of about 5 to 7 years, and only attains the latter age when carefully nursed. It is believed that it is now possible, by careful design and scrupulous care in manufacture, to increase the life under train-lighting conditions to 10 years. For any particular type of cell the cost of renewals of positive plates, which give out first, the cost of resuscitating negative plates and finally renewing them, and the cost of maintaining battery-boxes and renewing electrolyte and cleaning, can be quite accurately determined from experience. The battery-maker ought to constitute a lead-exchange, the user selling him old lead and old active material and buying new plates, paying the difference.

With large numbers of similar cells the matter of renewal becomes one of insurance only, and the cost of the maintenance and renewal of the lead cell for train-lighting is a matter which lends itself to accurate accounting. As far as the Author's experience goes, an annual provision of 10 per cent. per annum on the capital cost of the whole cell will pay for both maintenance during life and renewals of plates and of boxes.

It is to be remembered that if overcharging is automatically prevented, if over-discharging is prevented by careful supervision, and if maintenance is intelligently organized, the train-lighting battery in general leads a more healthy existence than the stationary battery on a lighting load in a central station, and is much less tried than a battery providing power for a motor-vehicle. In both these latter cases the cells, after continuous charge, are discharged down to or below the proper minimum limit. It is well known that a battery of lead cells floating on a traction-load, with enormous discharges for short periods immediately followed by corresponding charges, is in general living a healthier life than the battery used on a lighting-circuit subject to continuous discharge, and a train-lighting cell has a better chance even than the traction cell. At every stop, or slow-down of the train below the charging-speed of the dynamo, the battery, if the lamps are on, discharges for a short time. It is then recharged, and these alternations are particularly helpful. Occasionally, when a dynamo-belt comes off, or the dynamo fails, or when lights are left on for hours with the coach standing in a shed or siding, the battery is discharged right out; but if this is discovered in time and the cells recharged at once,

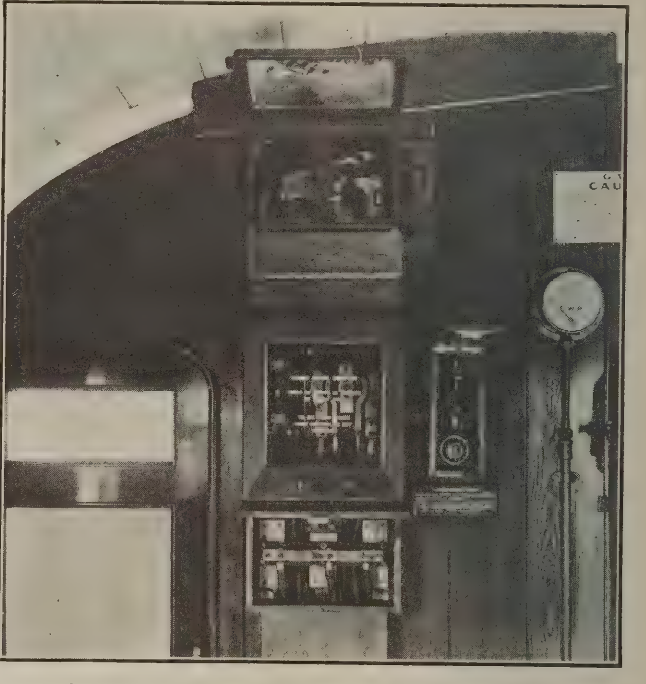


Fig. 5—Showing Location of Automatic Switch.

probably no great harm will be done. It is the Author's experience that chronic over-charging is much more harmful than occasional over-discharge, provided the cells are not left discharged for several days. If charging is stopped when the cells are full, the train-lighting battery works under favorable conditions in all sorts of traffic except when it is worked without notice on a slow, stopping, suburban service. In a slow, stopping service the time during which the battery is discharging may greatly exceed the time during which it is being charged, but even these conditions can be met for a few days unless the cells are regularly discharged below 1:8 volt.

Lamp-Regulation by Second Battery—For all lead cells the cost of material for maintenance varies with the size of the battery, though not directly as size. Within British train-lighting limits, maintenance-labor is practically the same per cell for any size up to about 250-ampere-hours capacity.

Battery-maintenance exceeds that of any other item of electric-lighting maintenance, so that, the fewer the

cells used, the less costly their maintenance, almost irrespective of size.

Before train-lighting days glow-lamp voltage had been regulated by employing two batteries of an equal number of cells. One battery was charged, while the other discharged direct to the lamps, the two batteries being connected in parallel through a resistance which reduced the voltage of charge to the voltage of the lamps. Unless the lamp load remain constant, or nearly constant, this system with a fixed resistance

Fig. 6—Showing Location of Battery.

between the charging and discharging batteries is really not an efficient regulator; it is possible, however, to regulate automatically the resistance between the two batteries, and under these conditions the voltage-regulation at the lamps can be kept within the prescribed limits.

The Generator.

Practically all of the car lighting generators on the Great Western are suspended pendulum fashion out of center as shown in Fig. 7, so that its weight supplies a known and constant belt tension. In addition to this a spiral-spring attachment to the dynamo-casing is re-

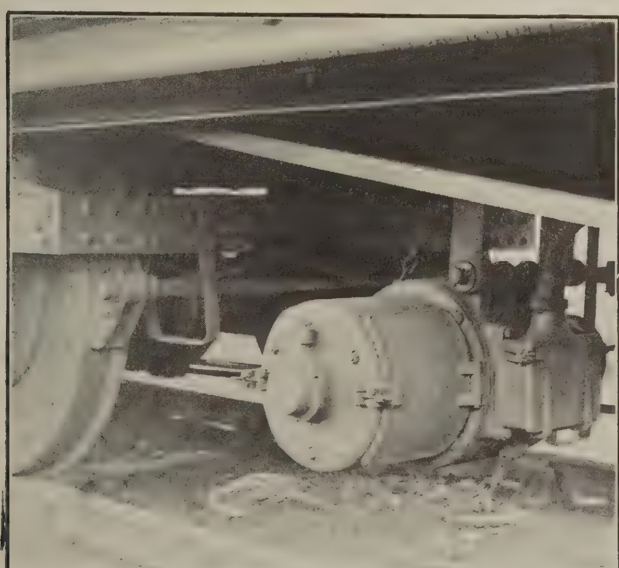


Fig. 7—Leitner Generator.

quired to give additional and adjustable belt-tension thus avoiding as far as possible the waste of power in the belt-slip. (Stone System regulates by belt-slip.) Belts are invariably used for driving the generator and the author reports that all types of belts are being tried, but an entirely satisfactory type has not yet been found.

The armature is mounted in ball bearings with grease lubrication, and aside from any slight reduction in friction losses, ball bearings save their extra cost in maintenance in a few months. The oil well needs far more attention than the grease-cup, and oil is a great nuisance in taking a dynamo off its suspension.

While the number of fuses used in train-lighting should be reduced to the minimum, there is little doubt that, to protect the dynamo and battery in case of failure of the automatic switch, a fuse is advisable in the armature-circuit; and fuses may be necessary in the field-circuit or circuits in some types of machines. These fuses should be of the enclosed type and be placed in a junction-box on the dynamo. All armature and field-leads between the junction-box and the coach-body should be enclosed in flexible metallic tubing.

As to the cutting-in speed, the author says that this should be 15 miles per hour on slow speed service, to 25 miles per hour on express service, while for suburban service it may be necessary to cut-in the dynamo at a speed of 5 miles per hour.

The Regulator.

There has been a dearth of invention in Great Britain with regard to automatic apparatus for controlling the whole equipment. In the United States and on the Continent numerous ingenious and more or less successful designs are at work, but in this country the second battery seems to have been considered amply sufficient for lamp-regulation, and both batteries were made as large as possible to minimize injury from overcharging. This fact is somewhat surprising; for it is difficult to think of a more stimulating problem than the design of an automatic switchboard-attendant to take note of the previous history as well as the present state of a battery and provide for its proper treatment, while at the same time securing constant voltage at the lamps, whatever the battery-conditions may be. The Author has no experience, other than such as can be gained from reading the results of tests carried out by independent engineers, of American and foreign regulators, but the two or three regulators designed and in use in England are complete and successful pieces of apparatus. The functions of an ideal regulator for electric train-lighting apparatus would appear to be as follows:—

First, it must control the lamp-voltage within 2½ per cent above or below the rated voltage of the lamps, and it must do this with a twelve-cell battery between the limits of a safe minimum discharge-pressure of 22 volts (when all regulating resistance will be cut out) and the maximum of 33 volts which may be required for a desulphating charge. Within reasonable limits this voltage-regulation must be independent of lamp load. If any lamps are on at all it is certain that, even in corridor stock, some three or four lamps are wanted in vestibule-ends and lavatories, and all requirements are met if voltage is kept constant between the limits of 10 per cent and 100 per cent of full load.

Secondly, as already described under the heading of the lead cell, the regulator, when the lamps are off, must control the generator-field, so as to allow the full output of the dynamo to charge the empty battery, and the balance of the full output (from one-third to one-half) necessary to supply the lamps when these are on. The regulator must further, as charging proceeds, gradually oppose the inherent rise in the dynamo-voltage, but only at such a rate as to tail-off the charging current. If properly set, the regulator can combine the advantages of constant-current charging and constant-voltage charging without the disadvantages of either. The regulator should reduce the charging current at this stage to at least 5 per cent of the full-load output of the dynamo until the battery is fully charged.

Thirdly, the battery being fully charged and the lamps being off, the regulator should reduce the charging current practically to zero which still alllowing the dynamo-field to be excited sufficiently to build up at once, and in the right direction, if suddenly called upon to do so by the switching on of the lamp load.

Fourthly, the battery being fully charged and the lamps being on, the output of the dynamo must be adjusted automatically so as to correspond exactly with the lamp load, wth the result that the battery, fully charged, is left floating on the load. Current neither enters nor leaves the battery, the whole of the lamp load being taken by the dynamo.

How the first and second conditions may be fulfilled is shown in Figs. 2 and 3, Page 210-11. The third and fourth conditions, however, can also be complied with, and it is possible to employ a regulator now which will at one and the same time take into account the immediately preceding battery-charge, with the consequent state of the battery, and also the actual voltage of the battery and the amount of the lamp load. It is believed that this covers all that should be required of an automatic regulator for train-lighting purposes.

(To be concluded in the March Issue.)

AN ENGLISH COMMENT ON THE ABOVE.

Few writers have attacked the problem of electric train lighting with greater thoroughness than Mr. Roger T. Smith, of the Great Western Railway, whose Paper to the Institution of Civil Engineers on the subject displays an intimate acquaintance with the subject. It is unfortunate that only one system was dealt with, as, apart from that used on the Great Western Railway there are other systems no less worthy of attention. Indeed, it is probable that, notwithstanding the author's claim to the contrary, a self-lighted coach on the Dalziel, Stone, or other system is superior to any system which depends for its reliability upon the integrity of the train as a whole.

Systems which depend on a small generator carried on a locomotive or baggage car are common on the Continent and in the United States, but self-lit carriages, i. e., carriages in which the electric lighting plant is an integral part of the coach equipment, have been preferred in this country. The Great Western Railway system is neither of these, inasmuch as it consists in equipping each brake van with an axle-driven generating plant, supplying current to the adjacent passenger coaches. Usually there are four coaches to a brake van, and the brake van equipment is therefore capable of dealing with this number, though there are composite and slip coaches, detachable at various junctions on a main line, all of which are brake coaches, and must therefore be fitted with self-lighting apparatus.

It seems that, notwithstanding the slightly lower cost of equipping block trains with this system, the complication of a system that is so lacking in uniformity and so likely to be disorganized by variations in the type of rolling stock which often occur during heavy traffic, is not likely to commend itself to railway companies.

Dealing with the cost, it seems that a six-coach train with a brake van at either end, both of which are equipped with the necessary generating and storage apparatus, costs £761, with an annual maintenance charge (battery, dynamo, lamps and wiring) of £44 18s.

Taking 500 coaches as equipped, the maintenance should average £6 per vehicle, while Mr. Smith estimates the corresponding charge for a self-lit system would be about £9 per vehicle per annum.

The locomotive charges for axle-driven plants have never been ascertained with any approach to accuracy, but Mr. Smith gets nearer to the truth by some very careful experiments. The difficulty in such investigations is that the power to be measured is but a small proportion of the locomotive's output, much less than 5 per cent, and the only way of measuring the drawbar pull is by a dynamometer car which has a probable error of 5 per cent. If therefore the amount to be measured is of the same order as the inaccuracy, it is difficult to ascertain whether a small variation of the figures is due to the measuring apparatus or to the power it is desired to measure.

From some experiments it appears that the extra drawbar pull necessary to light the train is of the order of 1.5 per cent of the total drawbar pull. The illustration reproduced below shows this very clearly. (See Fig. 8.)

Another item is the cost of hauling the electrical apparatus, dynamos, and batteries; they appear to weigh 1.7 per cent of the weight of the train.

From these two figures it is deduced that the power required to light a six-coach train costs £13 per annum, and the cost of hauling the equipment would be £15, giving the total locomotive costs for lighting a six-coach train of £28 per annum. The working costs already ascertained are £44 18s., say £45, giving a gross annual expenditure of £73.

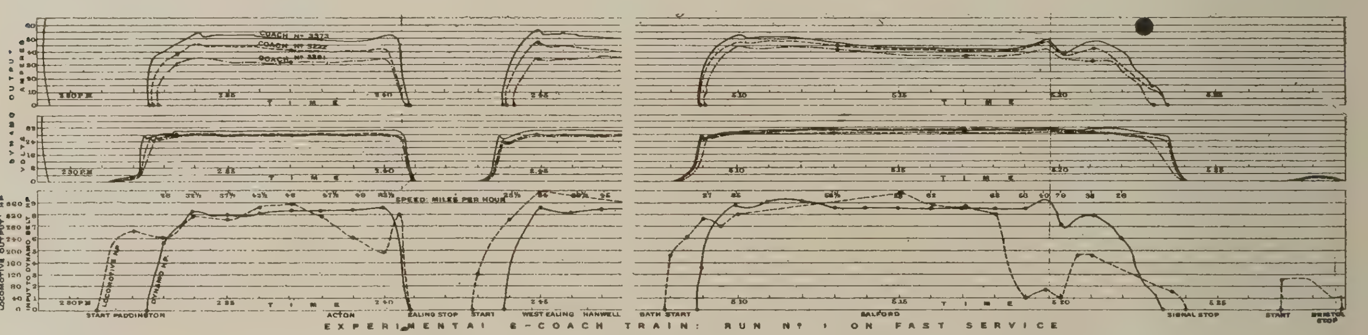


Fig. 8—Test of Leitner Equipment in Service.

A further charge for interest on capital cost per train (£761) is, say £30, and a sum sufficient to redeem the capital in 20 years would absorb £23, so that the annual cost of lighting a six-coach train, taking all charges into account, is £126.

It is only fair to point out that oil-gas lighting with inverted mantles could be carried out for less, but, notwithstanding this, the electric lighting of railway carriages continues to make headway, and will probably continue to do so. As evidence of this, we gather from a report of the committee of the Railway Electrical Engineers Association of the United States of America that out of 50,000 passenger cars in use on the steam railways 11,017 are electrically lighted, almost all modern stock. Of the systems in use, 1,372 cars are lighted by storage batteries, 3,185 cars are lighted from steam-turbine-driven generators on locomotives, or in the baggage car at the head of the train, and 5,900 cars have axle-driven generators.

The Pullman Car Company light 2,400 out of a total of 4,264 cars by electricity, and use axle-driven generators exclusively.—*London Engineering Review.*

ELECTRFICATION OF CHICAGO TERMINALS.

The Electrification of Chicago Terminals was the subject of a talk given by Mr. L. C. Fritch, chief engineer of the Chicago Great Western Railroad before the Electric Club of Chicago, Jan. 31.

Mr. Fritch said that Chicago is the greatest railroad center in the world, it being the radiating point for 80,000 miles of railroads, one-third of all the mileage in the country.

He divided the subject of electrification under two main heads of passenger traffic and freight traffic. Of the two, he considered the freight traffic by far the more important. Ten million freight cars annually are handled at Chicago, and this number is increasing 10 per cent every year. He said that the greatest need is for an adequate system of interchange of freight traffic, for over 30 per cent of all of the 10,000,000 cars received annually are through traffic which merely passes through Chicago.

There is an average delay in transferring freight cars of 72 hours. By a lectrified system of interchange, this could be easily reduced to 36 hours, and accordingly a great saving in time and money could be effected, as well as better facilities given the shipper. Railways terminating at Chicago actually lose much traffic because of the poor system of interchange of cars, it being routed so as to pass entirely around Chicago. The saving effected by an electrified freight interchange system would more than warrant the expense which electrification would involve.

As to passenger traffic, he said that the logical solution is to have all the railroads entering Chicago terminate in five central stations located side by side on 12th street. Office buildings could be erected over train sheds and station, the revenue of which would more than pay the interest and depreciation on the installation required for electrification. As an impressive example of this point, Mr. Fritch said that twenty city blocks in the heart of New York have been reclaimed by the electrification of the New York Central terminal. Ten to twenty immense office and apartment buildings are being erected on each of these blocks, and the revenue from these buildings will more than pay the interest on all the immense investment of the Grand Central Terminal.

As to the feasibility of the storage battery locomotive as a solution of the electrification problem, Mr. Fritch said that this could hardly be considered seriously, as the cost of a battery required to haul a 3,000-ton train would be prohibitive.

He said that one of the worst stumbling blocks in the path of electrification progress is the fact that no standard equipment has as yet been decided upon. If the various advocates of the direct current, single phase and three phase systems can get together and decide upon a standard equipment, one of the biggest objections to electrification will have been overcome. In considering the electrification of Chicago terminals this point is of greatest importance. On account of the fact that Chicago is a radiating point, there must necessarily be a uniform system of electric traction adopted. Electrification is bound to come, but any railroad adopting one of the three systems now recommended may find itself in a few years facing the embarrassing situation of scrapping its entire electrical equipment to conform to the electric traction system of other railroads with which it connects. There must be one system adopted and that system must be the right one before electrification of Chicago terminals can be attempted. Electrification of individual terminals as they are at present located in Chicago would be an economic waste.

SHOP SECTION
EDITED BY
GEO. W. CRAVENS

Shop Series 10—West Albany Shops, N.Y.C. & H. R. R.

The principal shops of the New York Central R. R. are located in the edge of the city of Albany, N. Y., in what is known as West Albany, and lie alongside the main line tracks. The buildings are arranged in two groups with the power house between them, the locomotive shops forming the easterly group. It was in these shops that the famous World's Fair locomotive "999" was built. This engine is really the progenitor of the modern high speed passenger locomotive and was a wonder in its day, but now looks very "old fashioned."

The layout of the shops is very compact without being crowded, there being plenty of space between all buildings for the movement of material. The natural lighting of these buildings is especially notable, a large portion of each wall being of glass. The five principal buildings of the locomotive shop group are virtually under one roof because of the arrangement

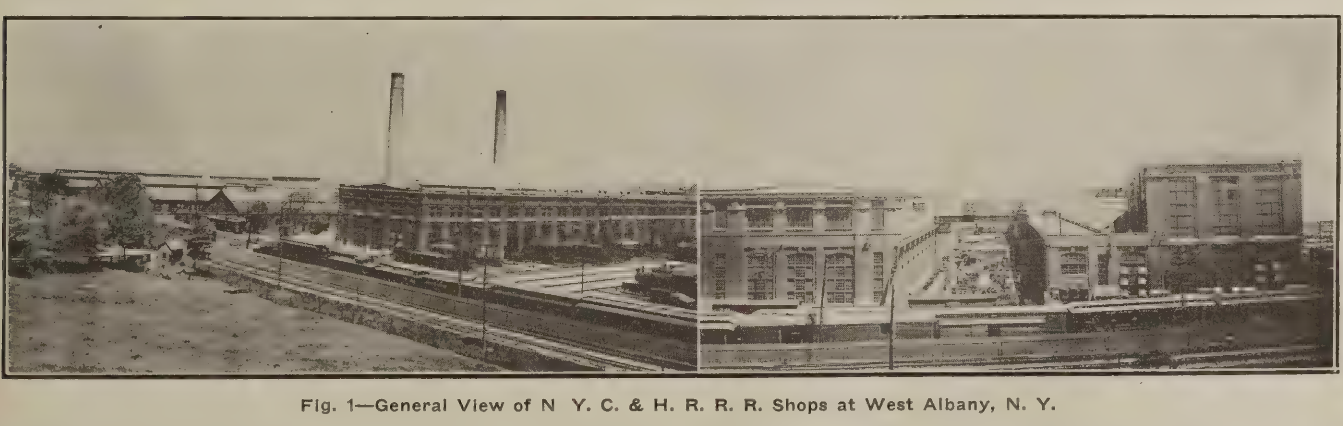


Fig. 1—General View of N Y. C. & H. R. R. R. Shops at West Albany, N. Y.

The machine and blacksmith shops are in a large building lying east and west, and the two erecting shops and the boiler shop are in three buildings forming wings on the south side of the main building. The paint shop, iron shed, turn table, etc., lie to the east and the power house and office building are to the west of this group. The car shops form a separate group of buildings to the west of the power house.

Three-phase alternating current is used in these shops almost exclusively, generated in their own power plant. The average day load is 1,800 k. w. and night load 700 k. w. Most of the machinery is driven by induction motors, about one-half of which were added to old tools by the shop force. There is also some 220-volt, 3-wire d. c. power in use. The arc lighting circuits total 900 k. w. at 2,300 volts, being stepped up from 480 volts through air cooled transformers and down to 110-220 volts on a 3-wire system for use in the shops. There are no motors on the lighting circuit, the lines being separate.

Power Plant and Heating System.

The power plant is located in a brick building 100 ft. wide by 200 ft. long, with two smoke stacks, and lies about the center of the groups of buildings. The stacks are of radial bricks and are each 165 ft. high, one being 10 ft. inside diam. and the other one 12 ft. 6 in. inside. The engine room and boiler room are each 50 ft. in width and extend full length of the building, the engine room floor being several feet higher than that of the boiler room and having a basement below containing auxiliary apparatus, workrooms, etc. A Niles 15-ton crane of 50 ft. span runs full length of the engine room and is mounted so it just clears the top of the switchboard in the gallery.

The boiler room contains 4 Franklin 500 h. p. water tube boilers and 3 Edgemoor 600 h. p. water tube boilers, all of which are equipped with Taylor gravity underfeed stokers. Here are also 2 blast fans for mechanical draft each driven by a 250 h. p. Bliss steam turbine. Their capacity is 30,000 cubic feet of air per minute. The hydraulic accumulator and auxiliary pump maintain a working pressure of 1,500 lbs. per square inch for hydraulic presses, etc. A coal crusher with a capacity of 50 tons per hour and the coal and ash handling apparatus with capacity of 40 tons per hour are installed here. They were made by the Link Belt Co., Chicago. Coal-hoppers are mounted overhead with leaders down to the stoker-hoppers in the usual manner.

The engine room contains 2 Ball & Wood 900 h. p. cross compound engines, each connected to a 600 k. w. General Electric a. c. generator, and 2 Ball & Wood 750 h. p. cross compound engines, each direct connected to a 500 k. w. Western Electric a. c. generator. Excitation for these generators is supplied by 2 Woodbury 50 h. p. engines connected to 35 k. w. General Electric d. c. generators. In addition to the a. c. generators there are 2 General Electric 300 k. w. d. c. generators driven by 435 h. p. synchronous 3-phase motors, 1 G. E. 100 k. w., d. c. generator driven by a 133 h. p., 3-phase synchronous motor, and a 75 k. w. G. E. d. c. generator driven by a 100 h. p. induction motor.

The auxiliary apparatus in the engine room comprises two Ingersoll-Rand two-stage air compressors with capacities of 2,400 cubic feet each, at 100 lbs. pressure, driven by Cooper-Corliss cross compound engines; two Duplex feed water pumps, 12x7½x10 in.; one 500-gal. centrifugal pump; one Davidson three-stage service pump of 3 millions of gallons capacity per day; one Duplex service pump, 20x10x18 in. with

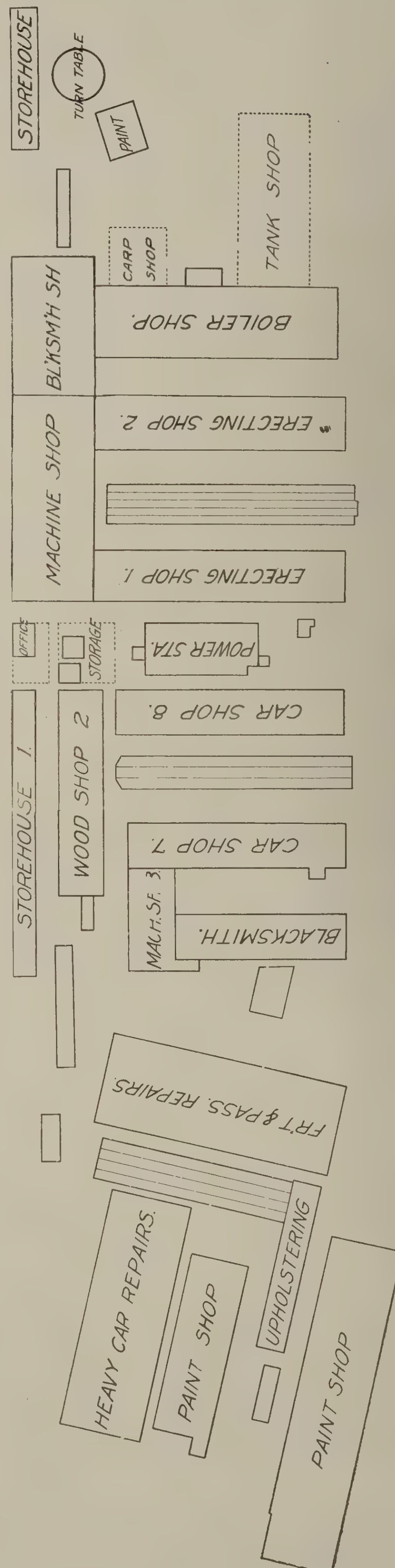


Fig. 2—Shop Layout.

a capacity of 1,500 gallons per minute; two oil circulating pumps, 4x4x6 in.; two "White Star" oil filters, and three vacuum pumps for the Webster & Donnelley heating system.

The engines exhaust into a combined muffler and grease extractor, from which the steam goes to heater coils in the various shops. The shops are warmed by air heated in passing over these coils and thence

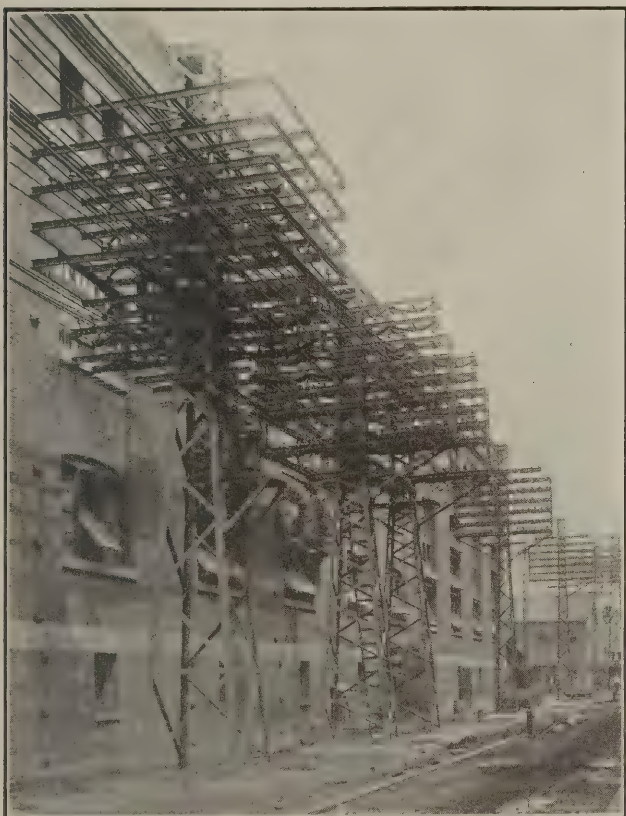


Fig. 3—Overhead Electrical Distribution System.

through ducts to all parts of the buildings, these coils being located through the shops as follows:

Machine Shop..........2	Boiler Shop............2
West Erecting Shop....2	Wood Mill.............1
East Erecting Shop.....2	Large Paint Shop......2
Blacksmith Shop.......2	Small Paint Shop......2

All the other shops are heated by direct radiation from steam coils. The maximum pressure of air maintained by the blowers is equal to that of a column of water 3 in. high. All returns operate on the Donnelley vacuum system which maintains a vacuum of from 8 to 10 inches. Cochrane feed water heaters are used for re-heating the water of condensation before returning it to the boilers. An automatic pressure regulator is provided to supply live steam to the heating system in case the pressure drops too low.

The blower fans for the heating system are driven by motors or engines as follows:

West Erecting Shop, Twin steam engines, each 25 h. p.
East Erecting Shop, 2 induction motors, each 35 h.p.
Machine Shop, 2 induction motors, each 35 h.p.
Boiler Shop, 2 induction motors, each 35 h.p.
Paint Shop No. 4, 2 induction motors, each 35 h.p.
Paint Shop No. 10, 2 induction motors, each 30 h. p.
Wood Mill, 1 induction motor, 30 h.p.

All of the above motors are of the variable speed type and drive fans through Morse silent chains. The practice here is to vary the speed of the fans to suit the weather conditions instead of changing the steam flow. The air ducts run overhead.

The large main switchboard is located in a gallery along the east side of the engine room, which allows the attendant to have a good view of the machines at all times. The switchboard consists of the following panels:

4 Main a. c. generator panels.
1 Totallizing a. c. panel with Tirrill regulator, graphic ammeter and recording wattmeter.
1 Totallizing a. c. panel for seven 480-volt feeder panels.
1 Transformer panel for three 200 k. w. step-up transformers.
1 Transformer panel for three 100 k. w. step-up transformers.
4 Exciter panels.
3 Starting panels for motor-generator sets.
3 Generator panels for motor-generator sets.
1 Totallizing d. c. panel with a Thomson recording wattmeter.
6 Feeder panels, 250 volts d. c.
7 Feeder panels, 440 volts a. c.
1 Series arc lighting panel.
1 Transformer panel for three 100 k. w. and three 200 k. w. step-up transformers.
8 Lighting feeder panels, 2,300 volts.

This switchboard was built by the General Electric Co. and their lightning arresters are installed in connection with the feeder lines.

Distributing System.

The method of distribution followed here is noticeable and very different from that usually followed in Railway Shops. All transmission lines run on steel towers and all indoor wiring is in conduits. The construction is massive and permanent all through, and separate feeders run from the switchboard to each distribution center throughout the shops and yards. Current for power purposes is distributed at 250 volts d. c. and 440 volts a. c., the later stepping down to 110/220 volts on a 3-wire system for use in the shops. A transformer is located outside each shop and no lights are operated on power circuits.

From the power house current is carried to dis-

Fig. 4—Night Illumination of Erecting Bay by Mercury Vapor Lamps.

tribution panels in each shop and thence to the various groups of motors. Each circuit is fused at the panels and equipped with a switch at the motor. In the locomotive shops there are 12 panels, 250 v. d. c., of 12 circuits each and 20 panels, 440 v. a. c., of from 6 to 12 circuits each, and in the boiler shop there are 22 panels, 440 v. a. c. of 2 circuits each. All motor starters and fuses are enclosed in boxes to protect employees. There are 12 Condit oil switches for con-

trolling motor circuits, and all a. c. motors over 5 h. p. have starting compensators.

All of the a. c. crane motors are Form M. General Electric induction motors, the list of cranes being as follows:

Machine Shop	a. c.—15	tons
Machine Shop	a. c.— 7½	tons
West Erecting Shop	d. c.—60	tons
West Erecting Shop	d. c.—60	tons
East Erecting Shop	a. c.—120	tons
East Erecting Shop	a. c.—40	tons
East Erecting Shop	a. c.—10	tons
Storage Yard	a. c.—20	tons
Boiler Shop	d. c.—40	tons
Boiler Shop	d. c.— 5	tons

Several of these cranes have secondary hooks in addition to the main ones for lifting light loads.

LOCOMOTIVE SHOP.

The west erecting shop contains 20 pits and 2 extra tracks, all lying crosswise of the building, and two 60-ton cranes running one above the other to facilitate passing. The building is 90 ft. wide by 440 ft. long and has a gallery extending full length along one side containing the tin and pipe shop. The hot air ducts are carried overhead among the roof trusses with 2 outlets between each pair of tracks, there being 31 hot air ducts 12x22 in. each side of the machine bay and 23 outlets 18x18 in. between the tracks. The natural lighting of this shop is excellent, and the artificial lighting is provided by 23 enclosed 6.6 ampere arc lamps each side on columns and 10 A. B. flaming arc lamps along the center and placed very high.

The east erecting shop is an older one than the west shop and is 95 ft. wide by 440 ft. long. It contains 20 pits and 2 tracks on 35-ft. centers similar to the other shop and the 120-ton and 10-ton cranes operate over the pits. The 120-ton crane has a 10-ton secondary hook and runs above the 10-ton crane. Over a 16-ft. aisle along the east side of this shop is a 40-ton crane, and the heating and ventilation is similar to that in the west shop. Lighting is by Cooper Hewitt mercury vapor tubes, there being 11 of them in the 16-ft aisle and 2 rows of 12 over the pits.

The machine shop occupies a building 360 ft. long by 145 ft. wide and contains a large tool room wherein most of the tools used in these shops are made. There is a 15-ton crane with a 2-ton secondary hook and a 7½-ton crane installed here. In a gallery at the west end of this shop is the brass department, the lighting of which is done by 3 Cooper Hewitt lamps. In the south half of the machine shop there are 30 Cooper-Hewitt lamps in 2 rows and in the north half there are 34 of them in 2 rows. In a narrow space 240 ft. long, over the tool room side of the shop, there are twelve 500-watt tungsten lamps installed on test to see how they compare with the Cooper-Hewitt lamps.

Most of the machine tools in these shops are motor driven direct, there being also a few group drives and some drives of air and steam. It is interesting to note by the accompanying lists how both a. c. and d. c. motors have been used to the best advantage instead of adopting one type only.

The blacksmith shop occupies the east end of the building containing the machine shop and is 240 ft. long by 145 ft. wide. One corner is devoted to the making of bolts, and the usual assortment of hammers, forges, etc., are there. The boiler shop extends to the south from the blacksmith shop and is 125 ft. wide by 430 ft. long. Across one end is the wheel section and in a gallery over one orner is the carpenter shop. It is proposed to build an extension to the east of the boiler shop 125 ft. by 275 ft. for a tank shop and one 100 ft. by 100 ft. for a carpenter shop.

Car Shops.

The group of buildings forming freight and passenger car shops lies to the west of the power house, and is unusually compact for so large a plant. There are 10 large buildings here in addition to a large store house and numerous sheds and other small buildings and two transfer tables. The buildings comprise 2 car building shops, a wood shop, a blacksmith shop, a machine shop, 2 paint shops, an upholstery shop and 2 car repair shops, one for heavy car repairs and the other for ordinary freight and passenger car repairs. The storehouse is 41 ft. 6 inches wide by 500 ft. long and lies along the north edge of the group, the others ranging along the main line tracks for about a quarter of a mile and being from 300 ft. to 500 ft. in length and from 80 ft. to 160 ft. in width.

A 60 ft. transfer table is placed between the two car erecting shops and serves 37 tracks, and a 75 ft. transfer is located between the 2 car repair shops and serves 18 tracks. A noticeable feature of these shops is the practice of placing roofs over the storage spaces throughout the yards instead of leaving material exposed to the weather. About the only things not covered are wheels, trucks and scrap, although there are some lumber piles at one end of the yards.

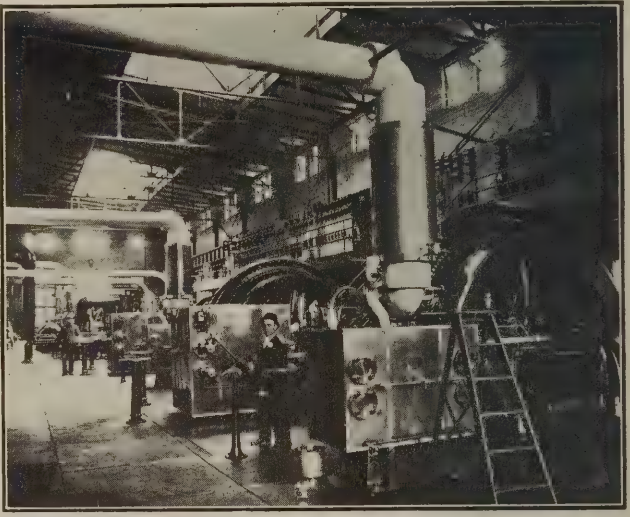


Fig. 5—Interior of Power House.

The car shops are well lighted, both by windows and skylights in many cases, and with a large number of lamps at night. There are approximately 400 arc lamps and 700 incandescent lamps installed in the car shops alone. The equipment of wood working and machine tools is unusually complete, and a. c. motors are used almost exclusively. The accompanying list shows the number of group and individual drives. A large number of hydrants are located between and through the buildings and fire protection is very well provided for.

Miscellaneous.

The present offices are located in an old building to the north of the power house, but it is proposed to erect a new brick office building in the near future which will contain offices for the various shop department heads and division accounting, a hospital and resident physician, and a lunch room for office employees.

It is also proposed to erect a new finishing shed for locomotives that will practically be nothing more

than a roof on columns and without sides. This will be a place for putting on the trimmings and finishing touches after they leave the erecting shop and before going out on the road for test.

The class room for apprentices is located in the ma-

Fig. 6—Interior of Machine Shop Showing Excellent Daylight Illumination.

chine shop over the brass room. There are 125 boys taking the apprentice course, ranging from 16 to 20 years in ages, and they get 2 lessons per week, during the morning. They are instructed in mathematics, drawing and machine design in addition to the practical work in the shops.

Lighting.

Shop.	Arc.	In-can-descent.	A. B. Flame Arc.	Cooper-Hewitt.
Power House...	20	...	..	18 (425 watt)
Loco. Shops.....	102	206	21	139 "
Freight Cars....	65	21	..	
Passenger Cars..	152	339	..	
Paint Shop.....	147	170	..	
Blacksmith Shop	16	14	..	
Planing Mill....	24	79	..	
Store Houses....	11	91	..	
Miscellany......	21	90	..	
Total........	558	1010	21	157

Located in the storage yard are 3 flue tumblers 48 in. in diam. Each of them holds 250 flues 21 ft. long and contains false heads for shorter flues. The doors at

Fig. 7—Night Illumination of Machine Shop by Mercury Vapor Lamps.

the ends are stationary, the barrel revolving between them. Each tumbler is driven by a 20 h. p. motor at a speed of 25 r. p. m.

A large transfer table runs between the two erecting shops, and a crane spans the storage yard between the east erecting shop and the boiler shop. A casting platform will also soon be constructed just north of the power plant. It will be 95 ft. square.

Another interesting feature of these shops is the large amount of overhead trolley or telpher carriers installed for hauling locomotive parts about the shops. These consist of steel bars mounted edgewise on hangers from the roof trusses overhead, or the floor beam above as the case might be, upon which run small cars or trolleys with two wheels from which are suspended hand operating chain blocks for hoisting. These trolley tracks are made with switches and turn-outs at intervals which are easily operated by hand, and many very short turns occur in the overhead track. The value of such a convenient system is apparent as it reduces the amount of trucking through aisles and over rough places in the floor.

The writer desires to extend his thanks to Messrs. John Howard, Supt. Motive Power; F. W. Brazier, Supt. Rolling Stock; L. A. Raymond, Supt. Shops, and Mr. M. J. Howe, Master Mechanic, of the New York Central Lines, for their courtesy and co-opera-

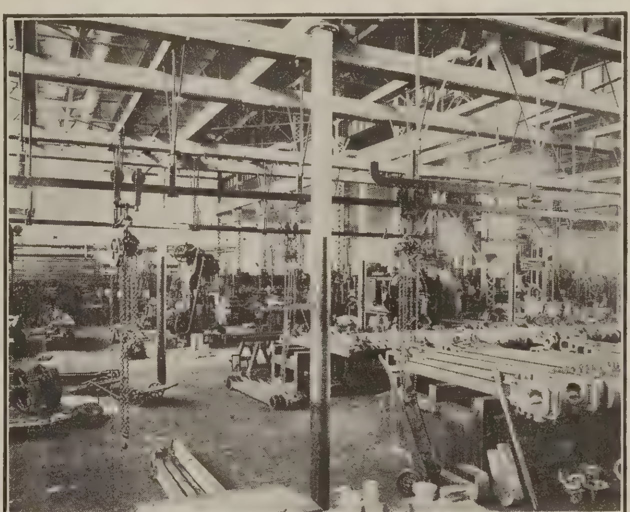


Fig. 8—Corner in Machine Shop Showing Hand Cranes and Trolley.

tion in assisting me to secure the data for this article. We also wish to thank the Cooper-Hewitt Electric Co. and Nimis & Nimis, contractors, for photographs illustrating parts of the installation.

TABLE I.
LOCOMOTIVE DEPARTMENT—MOTOR-DRIVEN MACHINES.

No.	.. Machine.	Motor Driving.
1	90-in. Driving wheel lathe	45 h. p. D. C.
1	90-in. Driving wheel lathe	10 h. p. D. C.
1	78-in. Journal lathe	10 h. p. A. C.
1	42-in. Truck wheel lathe	23 h. p. A. C.
1	24-in. Engine lathe	6 h. p. D. C.
1	24-in. Engine lathe	9 h. p. D. C.
1	24-in. Engine lathe	13 h. p. D. C.
1	24-in. Engine lathe	7.5 h. p. A. C.
1	18-in. Engine lathe	1.5 h. p. A. C.
1	16-in. Engine lathe	3 h. p. D. C.
1	18-in. Engine lathe	7 h. p. D. C.
1	18-in. Engine lathe	4.5 h. p. D. C.
1	16-in. Engine althe	5 h. p. A. C.
1	16-in. Engine lathe	2 h. p. A. C.
1	18-in. Engine lathe	3 h. p. D. C.
1	24-in. Engine lathe	7.5 h. p. D. C.
1	26-in. Engine lathe	5.5 h. p. D. C.
1	18-in. Engine lathe	5 h. p. D. C.

1 18-in. Engine lathe	5 h. p. D. C.
1 26-in. Engine lathe	7.5 h. p. D. C.
1 16-in. Tool room lathe	5 h. p. A. C.
1 24-in. lathe	10 h. p. D. C.
1 D. H. axle lathe	25 h. p. D. C.
1 20-in. brass lathe	5 h. p. A. C.
1 16-in. tool room lathe	3 h. p. D. C.
1 36-in. engine lathe	15 h. p. D. C.
1 30-in. engine lathe	10 h. p. D. C.
1 30-in. engine lathe	10 h. p. D. C.
1 Prentis lathe	5 h. p. A. C.
1 Prentis lathe	5 h. p. A. C.
1 Prentis lathe	5 h. p. A. C.
1 D. H. 42-in. boring mill	10 h. p. A. C.
1 D. H. 42-in. boring mill	10 h. p. D. C.
1 D. H. 10-ft. boring mill	22 h. p. D. C.
1 D. H. 36-in. boring mill	10 h. p. D. C.
1 D. H. 42-in. boring mill	12 h. p. D. C.
1 D. H. 42-in. boring mill	12 h. p. D. C.
1 D. H. 42-in. boring mill	12 h. p. D. C.
1 42-in. car wheel boring mill	7.5 h. p. A. C.
1 36-in. vertical boring mill	10 h. p. A. C.
1 42-in. vertical boring mill	15 h. p. A. C.
1 72-in. Tire boring mill	40 h. p. D. C.
1 Boring mill	12 h. p. D. C.
1 36-in. Planer	20 h. p. D. C.
1 24-in. Planer	20 h. p. D. C.
1 33-in. Planer	15 h. p. A. C.
1 60-in. Planer	20 h. p. D. C.
1 60-in. Planer	12 h. p. D. C.
1 32-in. Planer	10 h. p. A. C.
1 42-in. Planer	22 h. p. D. C.
1 32-in. Planer	10 h. p. A. C.
1 24-in. Planer	10 h. p. A. C.
1 cylinder planer	55 h. p. A. C.
1 6-ft. Radial drill	5.5 h. p. A. C.
1 6-ft. Radial drill	5.5 h. p. A. C.
1 34-in. Radial drill	5 h. p. A. C.
1 Drill	5 h. p. A. C.
1 6-ft. Radial drill	5 h. p. A. C.
1 60-in. Radial drill	5 h. p. A. C.
1 30-in. drill	5 h. p. A. C.
1 stay bolt rill	5 h. p. D. C.
1 Four spindle drill	7.5 h. p. D. C.
1 60-in. Radial drill	5 h. p. A. C.
1 20-in. Davis drill	1 h. p. A. C.
1 20-in. Davis drill	1 h. p. A. C.
1 20-in. Davis drill	1 h. p. A. C.
1 20-in. Davis drill	1 h. p. A. C.
1 20-in. Davis drill	1 h. p. A. C.
1 20-in. Davis drill	1 h. p. A. C.
1 20-in. Davis drill	1 h. p. A. C.
1 6-ft. Radial drill	10 h. p. A. C.
1 6-ft. Radial drill	20 h. p. D. C.
1 6-ft. Radial drill	20 h. p. D. C.
1 6-ft. Radial drill	20 h. p. D. C.
1 6-ft. Radial drill	20 h. p. D. C.
1 42-in. vertical milling machine	15 h. p. D. C.
1 48-in. horizontal milling machine	18 h. p. D. C.
1 No. 4. universal milling machine	6.5 h. p. D. C.
1 66-in. boring mill	12 h. p. D. C.
1 cylinder boring mill	16 h. p. D. C.
1 Cincinnati milling machine	7.5 h. p. D. C.
1 24-in. shaper	5 h. p. D. C.
1 24-in. shaper	3¾ h. p. D. C.
1 24-in. shaper	5 h. p. D. C.
1 16-in. shaper	3¾ h. p. D. C.
1 24-in. shaper	5 h. p. D. C.
1 shaper	7.5 h. p. A. C.
1 28-in. shaper	5 h. p. D. C.
1 28-in. shaper	5 h. p. D. C.
1 Grinder	5 h. p. A. C.
1 34-in. shaper	7.5 h. p. D. C.
1 gap ginder	10 h. p. A. C.
1 grinder	5 h. p. A. C.
1 grinder	10 h. p. D. C.
1 grinder	1.5 h. p. A. C.
1 24-in. grinder	10 h. p. A. C.
1 24-in. grinder	10 h. p. A. C.
1 24-in. grinder	10 h. p. A. C.
1 24-in. grinder	10 h. p. A. C.
1 24-in. grinder	10 h. p. A. C.
1 24-in. grinder	10 h. p. A. C.
1 24-in. grinder	10 h. p. A. C.
1 24-in. grinder	10 h. p. A. C.
1 grinder	3 h. p. A. C.
1 stay bolt cutter	5.5 h. p. A. C.
1 bolt cutter	5 h. p. A. C.
1 bolt cutter	5 h. p. A. C.
1 1½-in. bolt cutter	7.5 h. p. A. C.
1 4-in. bolt cutter	5 h. p. D. C.
1 Turrett lathe	5 h. p. A. C.
1 Turrett lathe	7.5 h. p. A. C.
1 600-ton wheel press	15 h. p. A. C.
1 25-ton wheel press	5 h. p. A. C.
1 25-ton wheel press	5 h. p. A. C.
1 150-ton wheel press	7.5 h. p. A. C.
1 wood turning lathe	5 h. p. A. C.
1 28-in. slotter	15 h. p. D. C.
1 15-in. slotter	10 h. p. D. C.
1 16-in. slotter	7.5 h. p. D. C.
1 16-in. slotter	7.5 h. p. D. C.
1 Key seating machine	2¾ h. p. D. C.
1 Bolt pointing machine	2 h. p. D. C.
1 quartering machine	10 h. p. A. C.
1 wood surfacer	7.5 h. p. A. C.
1 bolt turning machine	7.5 h. p. D. C.
1 six spindle nut tapper	5 h. p. A. C.
1 fan blower	60 h. p. A. C.
1 stay bolt machine	10 h. p. D. C.
1 fan blower	40 h. p. A. C.
1 fan blower	200 h. p. A. C.
1 flue cutter	3 h. p. A. C.
1 flue cutter	3 h. p. A. C.
1 flue cutter	4 h. p. A. C.
1 flue cutter	5 h. p. A. C.
1 punch No. 3	7.5 h. p. A. C.
1 punch No. 5	7.5 h. p. A. C.
1 punch No. 5	15 h. p. A. C.
1 spring machine	7.5 h. p. A. C.
1 punch & shears	7.5 h. p. A. C.
1 punch & shears	10 h. p. A. C.
1 spring machine	10 h. p. A. C.
1 12-ft. rolls	30 h. p. A. C.
1 8-ft. rolls	7.5 h. p. A. C.
1 spring machine	10 h. p. A. C.
1 500-pound hammer	10 h. p. A. C.
1 300-pound hammer	7.5 h. p. A. C.
1 2-in. bolt header	12 h. p. A. C.
1 forging machine	10 h. p. A. C.
1 forging machine	25 h. p. A. C.
1 rotary bevel shears	7.5 h. p. A. C.
1 shears	15 h. p. A. C.
1 shears	7.5 h. p. A. C.
1 shears	10 h. p. A. C.
1 shears	20 h. p. A. C.
1 flue rattler	20 h. p. A. C.
1 flue rattler	20 h. p. A. C.
1 Die sinking machine	3 h. p. D. C.
1 Bolt altering machine	3¼ h. p. D. C.
7 Fans for heating	35 h. p. A. C. each
1 Nut facing machine	1½ h. p. D. C.
1 Spring rolls	15 h. p. D. C.
1 150-ton wheel press	Water power
1 Hydraulic riveter	Water power
1 Mud ring riveter	Water power
1 Flue tester	Water power
1 Spring banding machine 1416 Evans Co., Phila.	Water power
1 Creenard press	Hand operated
1 Punch	Hand operated
1 4-ft. rolls	Hand operated
1 30-in. rolls	Hand operated
1 40-in. rools	Hand operated
1 4-ft. rolls	Hand operated
1 Burring machine	Hand operated
1 Burring machine	Hand operated
1 Burring machine	Hand operated
1 Circular cutter	Hand operated

LOCOMOTIVE DEPARTMENT—MACHINES DRIVEN IN GROUPS.

Group driven by 10 h. p. A. C. motor.

1 24-in. drill
2 Pipe threading machines

Group driven by 30 h. p. A. C. motor.

2 24-in. Engine lathes
2 20-in. Engine lathes
1 18-in. Engine lathes
1 14-in. Engine lathes
1 Shaper
1 Grinder
1 Centering machine

Group driven by 30 h. p. A. C. Motor.

1 20-in. Engine lathes
2 16-in. Engine lathes
2 24-in. Planers
1 18-in. Drill

2 5-ft. Radial drills
1 4½-ft. Radial drill
1 20-in. Drill
1 18-in. Hor. milling machine
1 24-in. Hor. milling machine
1 Boring mill
1 Turrett lathe
1 Centering machine
1 24-in. Engine lathe
1 42-in. Engine lathe
Group driven by 15 h. p. A. C. motor.
2 Tool grinders
1 30-in. Grinder
1 Grinder
1 Double-wheel emery grinder
Group driven by 10 h. p. A. C. motor.
1 Grinder
1 Buffing wheel
Group driven by 30 h. p. A. C. motor.
2 18-in. Lathes
1 24-in. Lathe
1 16-in. Lathe
1 Lathe
2 18-in. Brass lathes
1 Turrett lathe
1 Bench lathe
1 Hor. milling machine
Group driven by 20 h. p. A. C. motor.
1 Davis drill
1 Combined mortising machine
1 Tennon machine
1 Rip saw
1 Cross-cut saw
1 Band saw
1 Grind stone
1 Jointer

TABLE II.

CAR DEPARTMENT—MOTOR-DRIVEN MACHINE.

No.	Machine.	Motor Driving.
1	Grinder	1 h. p. A. C.
1	Grinder	3 h. p. A. C.
1	Wood lathe	3 h. p. A. C.
1	Wood lathe	3 h. p. A. C.
1	Boring machine	3 h. p. A. C.
1	Jig saw	3 h. p. A. C.
1	Inlayer	3 h. p. A. C.
1	Boring machine	3 h. p. A. C.
1	Boring machine	5 h. p. A. C.
1	Gainer	5 h. p. A. C.
1	Carver	5 h. p. A. C.
1	Swing saw	7 h. p. A. C.
1	Swing saw	7.5 h. p. A. C.
1	Band saw	7.5 h. p. A. C.
1	Wood planer	7.5 h. p. A. C.
1	Rip saw	7.5 h. p. A. C.
1	Mortising machine	7.5 h. p. A. C.
1	Gum sticker	7.5 h. p. A. C.
1	Sticker	7.5 h. p. A. C.
1	Sticker	7.5 h. p. A. C.
1	Swing saw	7.5 h. p. A. C.
1	Swing saw	7.5 h. p. A. C.
1	Swing saw	7.5 h. p. A. C.
1	Flag stick machine	7.5 h. p. A. C.
1	Mortising machine	7.5 h. p. A. C.
1	Boring machine	10 h. p. A. C.
1	Rip saw	10 h. p. A. C.
1	Boring machine	10 h. p. A. C.
1	Boring machine	10 h. p. A. C.
1	Boring machine	10 h. p. A. C.
1	Boring machine	10 h. p. A. C.
1	Band saw	10 h. p. A. C.
1	Skid	15 h. p. A. C.
1	Mortising machine	15 h. p. A. C.
1	Wood shaper	15 h. p. A. C.
1	Rip saw	15 h. p. A. C.
1	Jointer	15 h. p. A. C.
1	Gainer	15 h. p. A. C.
1	Gainer	15 h. p. A. C.
1	Gainer	15 h. p. A. C.
1	Blower	15 h. p. A. C.
1	Boring machine and gainer	15 h. p. A. C.
1	Planer and blower	15 h. p. A. C.
1	Rip saw	15 h. p. A. C.
1	Gainer	15 h. p. A. C.
1	Rip saw	20 h. p. A. C.
1	Sticker	25 h. p. A. C.
1	Wood planer	25 h. p. A. C.
1	Blower	25 h. p. A. C.
1	Saw	25 h. p. A. C.
1	Sticker	25 h. p. A. C.
1	Sticker and jointer	25 h. p. A. C.
1	Saw	25 h. p. A. C.
1	Sticker	25 h. p. A. C.
1	Blower	35 h. p. A. C.
1	Sand paper machine	35 h. p. A. C.
1	Wood planer	35 h. p. A. C.
1	Blower	50 h. p. A. C.
1	Wood planer	50 h. p. A. C.
1	Wood planer	75 h. p. A. C.
*1	Blower	50 h. p. A. C.
1	Drill and punch	20 h. p. A. C.
1	Shaper	20 h. p. A. C.
1	Wheel press	20 h. p. A. C.
1	Blower	15 h. p. A. C.
1	Blower	15 h. p. A. C.
*1	Blower for heating system	55 h. p. A. C.
*1	Saw	5 h. p. A. C.
1	Swing saw	20 h. p. A. C.
1	Test motor	5 h. p. A. C.
1	Motor for generator set	30 h. p. A. C.
*1	Small hammer	5 h. p. A. C.
1	Bull dozer	30 h. p. A. C.
1	Shears	8 h. p. A. C.
1	Hammer	5 h. p. A. C.
1	Punch	5 h. p. A. C.
1	Shears	5 h. p. A. C.
1	Punch and shears	7.5 h. p. A. C.
1	Punch and shears	7.5 h. p. A. C.
1	Forging machine	25 h. p. A. C.
1	Bolt tapper	20 h. p. A. C.
1	Bolt machine	15 h. p. A. C.
*1	Pipe machine	7.5 h. p. A. C.
1	Pipe Machine	5 h. p. A. C.
*1	Brush and beater	15 h. p. A. C.
1	Sewing machine	1 h. p. A. C.
1	Sand blower	15 h. p. A. C.
*1	Band saw	5 h. p. A. C.
1	Heating fan	25 h. p. A. C.
*1	Wheel lathe	45 h. p. D. C.
1	Axle lathe	20 h. p. D. C.
1	Shaper	5 h. p. D. C.
1	Motor in plating room	5 h. p. D. C.

CAR DEPARTMENT MACHINES DRIVEN IN GROUPS.

Group driven by 20 h. p. A. C. motor.
1 Band saw
1 Mortising machine
1 Wood drill
1 Wood planer
1 Grind stone
Group driven by 20 h. p. A. C. motor.
3 Buffing wheels.
1 Lathe
Group driven by 1 h. p. A. C. motor.
2 Grinders
Group driven by 10 h. p. A. C. motor.
1 Knife grinder
1 Battery machine
1 Band saw filer
1 Saw grinder
1 Emery wheel

1	Cutter	Hand operated
1	30-in. Folder	Hand operated
1	60-in. Folder	Hand operated
1	Folder	Hand operated
1	30-in. Folder	Hand operated
1	Turning machine	Hand operated
1	Turning machine	Hand operated
1	Swedging machine	Hand operated
1	Swedging machine	Hand operated
1	Wiring machine	Hand operated
1	Belt lacing machine	Hand operated
1	2000-pound hammer	Steam operated
1	300-pound hammer	Steam operated
1	600-pound hammer	Steam operated
1	4500-pound hammer	Steam operated
1	1500-pound hammer	Steam operated
1	1800-pound hammer	Steam operated
1	2700-pound hammer	Steam operated
1	6000-pound hammer	Steam operated
1	Flue welder	Air operated
1	Flue welder	Air operated
1	Flue welder	Air operated
26	Furnaces	Operated by oil and air
2	Crude oil heaters	Air operated
3	Flanging clamps	Air operated

A.B.C. CAR LIGHTING SERIES
EDITED BY EDWARD WRAY

In this series of plain talks it is our purpose to give the reader the nearest equivalent to a Correspondence School course in Electric Car Lighting that is possible in a monthly journal. As the field to be covered is highly specialized and complex, we realize that it is no small task we are undertaking, and accordingly we hope that our more experienced readers will co-operate with us in offering frank criticisms and suggestions.

A question box department will be established in connection with this series. Let us know of any special trouble you encounter or points not thoroughly understood and we will endeavor to clear them up for you.

The subjects to be covered in this series are as follows:

- Principles of Electricity and Magnetism.
- The Generator and the Motor.
- Solenoids.
- The Storage Battery.
- Axle Generator Systems.
  - Description of Various Equipments.
  - Installation of Axle Equipment.
  - Belts and Pulleys.
  - Bearings.
  - Lamps and Reflectors.
  - Car Wiring.
  - Troubles and How to Shoot 'em.
  - Questions, Answers, Etc.
- Headend System.
  - The Steam Turbine.
  - Engine Generator Sets.
  - Car Wiring.
  - Various Methods of Charging Batteries on Headend Systems.
  - Troubles and How to Shoot 'em.
  - Questions, Answers, Etc.
- Electric Headlights.

Talk No. 1

PRINCIPLES OF ELECTRICITY AND MAGNETISM.

In the space about the poles of any magnet there is a peculiar condition which maintains, known as "Lines of Force". These extend from pole to pole and have the characteristics of a bundle of rubber bands stretched tight and ready to shorten at the first opportunity. This analogy is, however, hardly exact, as these magnetic lines seem to have a repelling effect on each other, so that some are driven in great sweeping curves out into space about the magnet as shown in Fig. 1. These lines of force become less effective the further they are from the pole pieces.

When the end of a magnet is inserted in iron filings and then withdrawn, it picks up a mass of the filings which cling to it very strongly. Either end of the magnet will pick up filings in a similar manner although the middle does not attract them to any extent. This shows that practically all of the magnetic lines of force are about either end of the magnet. If this bar is then broken in two, it will be found that we have two magnets each both ends of which have the same properties of picking up filings as the original magnet. This shows that these magnetic lines of force pass directly through the magnet.

If a compass be brought near one of the poles of the magnet the needle will either be attracted or repelled. Unlike poles attract, so that if the north pole of the compass is attracted it indicates that that pole of the magnet is a south pole and vice versa. The earth itself

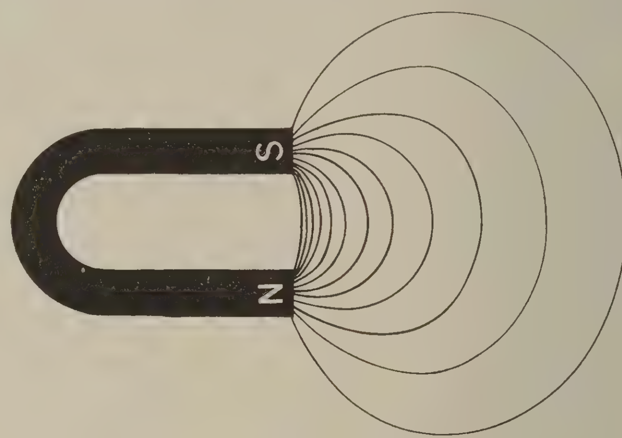


Fig. 1.

is a great magnet which causes the compass needle to point toward the north.

They are called "Magnetic Lines of Force" for want of a better name. As a matter of fact a magnetic field does not exist in the form of lines at all but is a peculiar condition of strain in the ether pervading all the space near the magnet which we do not yet know enough about to define clearly. It makes it much easier to explain some of the phenomena of magnetism, however, to assume that it is made up of lines of force.

Iron offers the least resistance to passage of these lines of anything known, so that when a piece of iron is

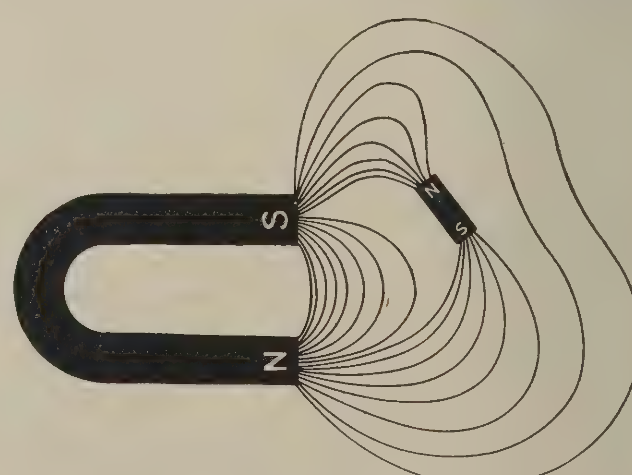


Fig. 2.

placed near a magnet the magnetic lines of force of that magnet crowd into the iron as shown in Fig. 2. They then act like the bundle of rubber bands referred to, and if, in sufficient number to overcome gravity or friction, as the case may be, will draw the iron to the pole faces of the magnet. This is the principle upon which all lifting magnets work except that the magnetic field is produced electrically, as will be described later.

It will be noticed in this discussion that nothing is said about static electricity as there is so little practical reference to be made to it in connection with this work.

There is a peculiar relation that exists between electricity and magnetism, in fact, the operation of all electrical machinery is based upon this relation, so that it is absolutely essential that the following be well understood. Whenever an electric current passes through a wire there is immediatelv a magnetic field created about that

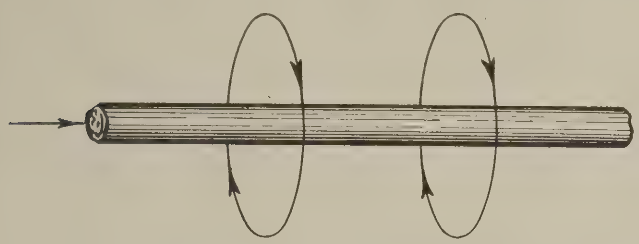


Fig. 3.

wire, the lines of force of which are in concentric circles about the wire, more dense nearer the wire and diminishing in density further away. These lines are exactly of the same character as those of the permanent magnet, although usually much weaker. It is possible, however, to combine these lines of force and make a powerful electromagnet as used in motors and generators.

To illustrate this principle, Fig. 3 shows a wire carrying an electrical current with the magnetic lines of force about it in the direction as shown. If, however, another wire carrying a current going in the same direction is brought along side of this wire, the magnetic lines, created by the two will combine encircling both wires as shown in Fig. 4, and will be of double strength.

Now then, extending this principle to a coil of wire as per Fig. 5 it is readily seen how the magnetic lines about each of the turns in the coil combine and form in lines that thread through the entire coil creating a powerful magnetic field in the center of the coil which is very similar in character to that of a permanent magnet.

The strength of this magnetic field depends upon the number of turns of wire in the coil and upon the current flow. 100 turns with 1 ampere flowing will have

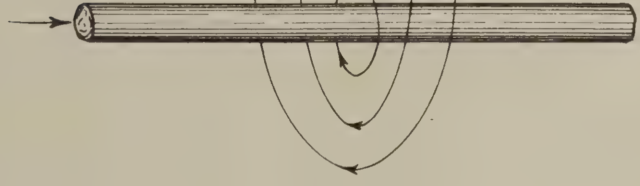


Fig. 4.

the same magnetising effect as 50 turns with 2 amperes flowing through the wire. This point will be taken up later in considering solenoid design so will not be considered further here.

Now if an iron core is inserted in this field, the number of magnetic lines will be tremendously increased on account of the fact that iron offers a much less resistance to passage of these lines than air or any other metal. It helps in understanding the action of any electro-magnet if we consider these magnetic lines of force as a simple electrical circuit; the magnetising lines of force of our original coil of wire, Fig. 5, is the storage battery or source of voltage; air, iron or other metal as the case may be, through which these lines of force pass, is the lamp circuit.

Now, since iron is of much lower magnetic resistance than any other substance, placing a piece of iron in the core of a solenoid will be exactly equivalent to greatly reducing the resistance in our assumed storage battery lamp circuit. The magnetic flux, or flow of magnetism, will be greatly increased just as the electrical current flow will be greatly increased if we replace a 16 candle power lamp having a resistance of 220 ohms with a 500 watt lamp having but 22 ohms resistance.

If, in addition to the iron core, a return path of iron outside the coil be provided, the magnetic flux will be still more increased. That is why the iron cores of transformers are made in closed rings, so that there will be the least resistance to the flow of magnetism.

The quality of the iron has a marked influence on its magnetic properties, generally a soft pure iron is most satisfactory. This property of carrying magnetism is known as "Permeability," the equivalent of conductivity in speaking of electric current flow.

As stated above the strength of an electro magnet depends upon the number of ampere turns (amperes $\times$

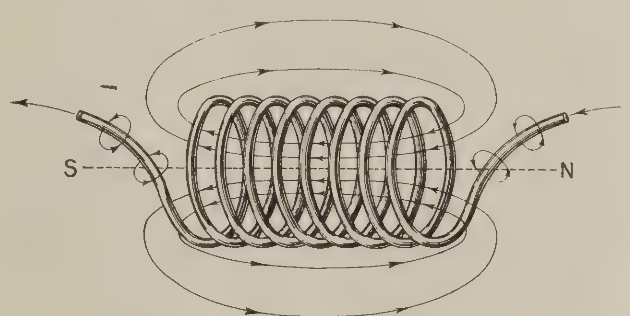


Fig. 5—Elementary Solenoid.

turns) and upon the magnetic reluctance (resistance) of the circuit, i. e., whether there is a complete path of iron provided, a good grade of soft iron used, etc. The ampere turns of magnetising force need not be all generated in one coil, there may be several coils wound on the same core—as in an automatic switch winding of the Bliss, Gould and Safety types. We have there a shunt winding consisting of a great number of turns of fine wire through which a small current is passed, and wound on this coil are a few turns of very heavy wire through which all the generator current passes. The shunt magnetism is always in the same direction and the magnetism of the series coil is normally in the same direction as that of the shunt coil. When the current reverses due to fall in generator voltage, and the battery starts to run the generator as a motor, the magnetism of the series coil will reverse with the reversing current flow and it will then oppose the shunt magnetism neutralizing it to such an extent that it will not be strong enough to hold the automatic switch closed.

We have seen how a magnetic field is created about any wire carrying an electric current and how, when that wire is wound in a coil, the magnetism is collected and formed into an electro magnet, similar in its properties to the common horse-shoe magnet; it is now interesting to see that the proposition works equally well when the situation is reversed, that is, if lines of force are wrapped around a wire an electric current will be induced. If a wire is drawn quickly across the pole-face of a magnet an electro motive force, or electrical

potential, is developed in that wire, and if the ends of the wire touch, an electric current will flow because of the fact that magnetic lines of force are being wrapped about the wire as it moves across the pole face (Fig. 6) and since we found a wire carrying a current had magnetic lines of force about it, it is conversely true that a wire with lines of force wrapped about it must carry an electric current. This is the principle upon which all generators operate and it will be more fully described in next month's talk on "Generators and Motors."

If we now bend this conductor into the form of a single coil as shown in Fig. 7, so that it will revolve in the magnetic field, it will cut through all of the magnetic lines twice in every revolution, once up and once down. This will cause a current to flow, first in one direction, and then in the other, reversing every half revolution.

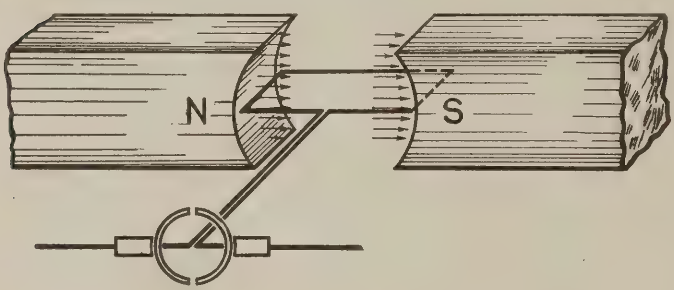


Fig. 6—Elementary Generator.

By having a commutator contact, however, as shown, the direction of current is rectified. On each half revolution a new segment comes in contact with the brushes and although the current within the coil reverses twice every revolution it flows in the external lamp circuit always in the same direction (Fig. 7). When the coil is cutting through the magnetic lines at the maximum rate (position in Fig. 7) there will be a maximum voltage developed, and when it reaches a position midway between the poles and moves in a direction parallel to the magnetic lines not cutting through them at all, the voltage developed will fall to zero. With a two-wire coil, therefore, this current flow will be very weak and will be of a pulsating nature.

If, on the other hand, instead of having one coil, there are a great number of coils connected to numerous commutator bar segments, we have a direct current generator or motor of the present day.

This series of plain talks will be continued in the March issue with a discussion of Generators and motors.

Ideas of Practical Men

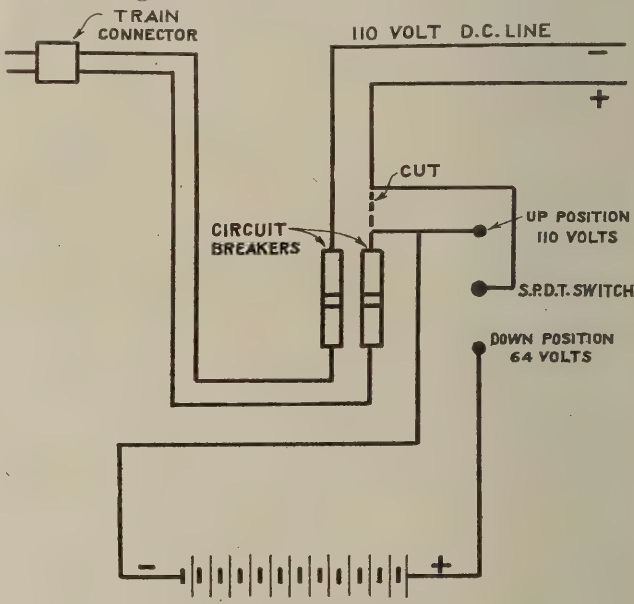
We pay for ideas published in this section. Send us some of your stunts. It will be a good thing for us, a good thing for you and a good thing for everybody that reads the paper.

On account of the two voltages now in use on head-end systems, 60 and 110 volts, it often becomes necessary to light two trains, one at 60 volts and one at 110 volts from the same city service while standing in a terminal station. The 60 volt train circuit, however, may be operated from the 110 volt city circuit by placing a single pole double throw knife switch in series with the positive side of the line between the line and the automatic circuit breaker. The blade of the switch is connected to the line, one point, to one of the circuit breakers, the other point of the switch leads to the positive terminal of 12 ordinary car lighting cells in series. The negative terminal of this little battery is connected back to the top of the circuit breaker as shown in the accompanying diagram.

The operation is as follows: When the switch is closed and in the "up" position 110 volts is delivered to the train but when it is in the "down" position the 110 is opposed by the counter electro motive force and internal resistance of the storage batteries and the result is 64 volts on the 64 volt train.

The only thing to be watched out for is to have the switch always in the right position for the 64 volts train, also have all lights turned on in the cars before closing the special circuit breakers in the box on the post, as with only a few lights on the voltage will be a little too high.

Almost any old batteries will do so long as they are free from shorts, and I find that there is less change in the voltage with this scheme than where using



some fixed resistance which has a tendency to heat up. You see we care nothing whatever about the capacity of the cells as we are only concerned in the counter electromotive force and although the current passing through is above the normal charging rate it makes no difference with an old worn out set of cells.

This scheme was made necessary on account of inauguration of new Sunset Limited trains from San Francisco to New Orleans, which were arranged for 64 volts while at the same time continuing with the 110-volt Lark trains between San Francisco and Los Angeles.

E. M. C.

NEW HAVEN TO EXTEND ELECTRIFIED ZONE.

Announcement has just been made to the effect that the New York, New Haven & Hartford will extend its electrified zone from Stamford to New Haven, a distance of 41 miles. Twenty-five cycle, 110,000 volt, single phase overhead catenary system will be employed similar to that now under construction on the Harlem River Branch and on the New York, Westchester & Boston Line.

The construction of the overhead system will be begun within the next six months and completed in about one year. Until the line is ultimately extended beyond New Haven, all energy for operating trains will be supplied from the generating station at Cos Cob.

With this latest extension of the electrified zone, the electric locomotives will cover a total distance of 75 miles between New York and New Haven, and will completely supersede the steam locomotives for both freight and passenger service throughout this zone.

MOON ELECTRIC HEADLIGHT.

In the report of the series of investigations of the Electric Headlight made by Prof. C. H. Benjamin of Purdue University at the request of Judge Wood, chairman of the Railroad Commission of Indiana, the objections found to the electric Headlight in railroad service were that it sometimes caused false semaphore signals to an approaching engineer on double track divisions,

Fig. 1—Turbine Set with Generator Case Open.

and that it presented a blinding glare, which made it impossible for him to see clearly passing an approaching headlight.

The new headlight developed and now manufactured by the Moon Mfg. Co., of Chicago, seems to eliminate these difficulties entirely, and at the same time has many other points of advantage which should commend it to the favorable consideration of railroad men.

The headlight is a combination of both arc and incandescent lamps as shown in Fig. 3. The arc being employed when on the road, but when standing on sidings, passing an approaching train on double track, running

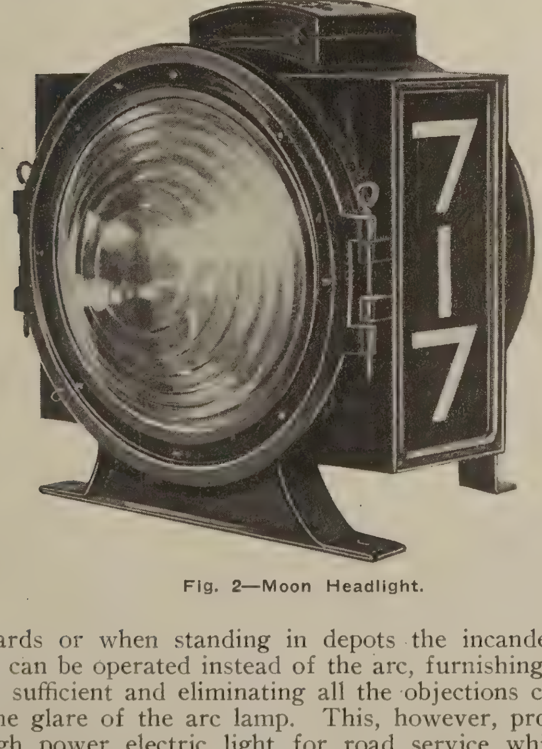


Fig. 2—Moon Headlight.

in yards or when standing in depots the incandescent lamp can be operated instead of the arc, furnishing light quite sufficient and eliminating all the objections caused by the glare of the arc lamp. This, however, provides a high power electric light for road service which is obtained by merely throwing a two way switch in the cab extinguishing the incandescents and cutting in the arc or vice versa.

There is another radical departure in this headlight in that the use of the parabolic reflector is omitted, a concentrating lens in front of the arc being substituted. This not only eliminates the constant trouble and expense of polishing reflectors, it being necessary to merely wipe off the lens with a clean piece of waste, but the light produced is a strong white light with a non-sparkling effect. Glass breakage due to uneven and extreme heating is also eliminated on account of the fact that while with the parabolic reflector the hottest part of the beam is at the center, decreasing uniformly towards the periphery. With a lens, the light rays are picked up uniformly, and projected therefrom, the heat not only becoming uniform, but very slight. On looking at this light from the front, all direct or unreflected rays known as sparkle are eliminated, these being gathered up by the lens into the beam of effective light. It is claimed by the maker that nothing but an accident ever breaks the lens.

Instead of the use of customary carbons, the arc is produced with what is known as "Electrodes," which not only produce a bright white light, but burn from 8 to 10 nights on one trimming. In fact, the upper or

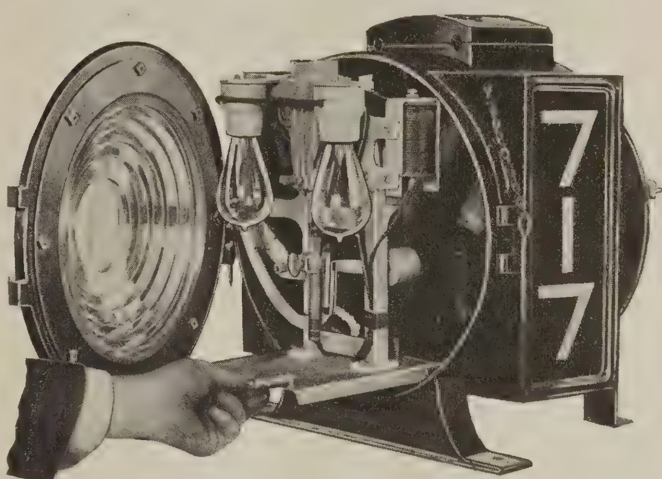


Fig. 3—Removing Arc and Incandescent Lamps.

negative electrode will burn a year or more. The consumption of these electrodes are practically negligible. It is evident that the arc is accordingly maintained in its proper position which provides for correct focus. The entire mechanism of the headlight can be entirely removed from the casing as easily as a chimney from an ordinary oil lamp, and without disturbing the wiring as shown in Fig. 3. In fact, the lamp is so simple in construction, that there is little to go out of order.

The turbo-generator is of special design and construction, the armature being form wound, with compound fields which compensate for the variation in the load occurring when the headlight or marker lights are extinguished, the cab lights remaining constant. The armature is mounted on a sleeve, which enables it to be removed from the shaft without disturbing any of the general parts except the end bracket. As will be seen from Fig. 4, the entire internal mechanism is easily removed. The generator is of special design to meet the requirements of this particular service.

The turbine is of special design, and quite a radical departure from all past practice. The turbine wheel is constructed from rustless pressed steel with bronze mounting, combining strength with smoothness of surface which is so essential in turbine construction where steam passes over the surface of metal at a high velocity, as it does with the turbine principle. It has been shown that

the higher the polish which can be obtained on the surface of the wheel or buckets, the less resistance is offered to the passing steam, and which is so essential to efficiency. The steam is emitted from two nozzles 3-16 inches in diameter located on diametrically opposite sides of the wheel forming a balance of torque which eliminates all stress on the bearing. There are no moving parts in the steam with the exception of the turbine wheel.

The turbine head is provided with a specially constructed opening where the shaft enters it, which eliminates the use of packing entirely.

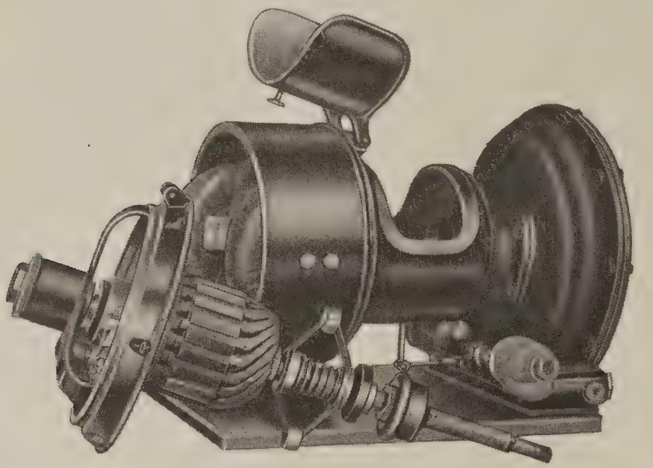


Fig. 4—Generator Dismantled.

The governor which operates the control valve is of special design, unique, and exceedingly sensitive in its action. The connections from the governor to the balance valve are of bronze and case hardened steel as shown in Fig. 4. The machine is provided with ball bearings throughout, there being no rubbing contracts with the exception of the brushes on the commutator. The general construction is of circular form, enabling all finished parts to be turned to a true surface, this insuring more perfect fitting and better standardization of parts. The casing is both water and dust-proof and ample provision has been made for easy inspection of parts. On account of the exactness and standardization in manufacturing, which are rigorously maintained, all parts of this equipment are made so as to be readily replaced with new parts to fit accurately.

The equipment operates on from 30 to 40 lbs. of boiler pressure, consuming a little over 100 pounds of steam per hour, to maintain the headlight and cab lights. By means of the compound windings of the generator and the accuracy with which the turbine is governed the cutting out of the headlight has no appreciable effect on the cab lights, the voltage remaining practically constant. The equipment operates at the standard voltage of 110, and with a capacity of 8 amperes or 900 watts, although the arc headlight and cab lights consume only about 600 watts.

THE STORAGE BATTERY CAR.

On January 23rd, Mr. H. E. Pratt of the Gould Storage Battery Co., presented a paper on the Storage battery car before the Electrical Vehicle Association of America. The author gave a brief history of early developments in storage battery cars, and then described the storage battery car equipment of the Third Avenue Railroad Company of New York. This company has at the present time a total of 65 storage battery cars in operation on its lines. Up to January 15th, 1912, the average mileage made by the original 32 cars installed in September and October, 1910, was approximately 20,000 miles per car

The cars operated by the Third Avenue Railroad Company are of the single-truck type. The length over all is 26 ft. 1½ in., the width of the body is 7 ft. 6 in. and the height over all is 10 ft. 4½ in. The seating capacity of the car is twenty-eight, and it weighs, without passengers but fully equipped, 7 tons. Two General Electric series motors rated at 30 amp and 110 volts are used on each car. The controllers are of the series-parallel type, arranged for operation from either end. Double ball or roller bearings are used on the wheels, and the motors are equipped with ball bearings. The cars are lighted by tungsten lamps, and the batteries are placed under the car seats in a specially ventilated compartment.

While the battery in the original car consisted of forty-four cells of 29-plate Gould high-capacity type with an amp-hour capacity of 420, the number of cells in the later cars was increased to fifty-eight. Under regular operating conditions the average speed of the car is 7 miles an hour, and the maximum speed on a level track is 15 miles an hour. Runs of from 92 to 105 miles are of daily occurrence. The energy consumption of the cars is remarkably low, varying from 60 to 70 watt-hours per ton-mile. This figure, of course, depends to some extent upon the care and skill of the motorman in handling the controller and brakes, and the company has installed amp-hour meters in all of the cars in order that a record of the performance of each motorman and car may be had.

The energy for charging the batteries is obtained from the Kingsbridge generating station over high-tension lines and transformed at the car barns. Including the loss in transmission, transforming and battery efficiency, the actual energy consumed averages between 0.9 kw.-hour and 1.1 kw.-hours per car-mile. The cost of operating the cars, exclusive of platform expenses, is approximately 7 cents per car-mile, this figure including energy at 1 cent per kw.-hour, battery maintenance, oil or grease and repairs to the mechanical and electrical parts. While this cost is considerably lower than that of the cars operated on underground conduit lines, it should be borne in mind that the latter are considerably heavier and also have greater passenger-carrying capacity.

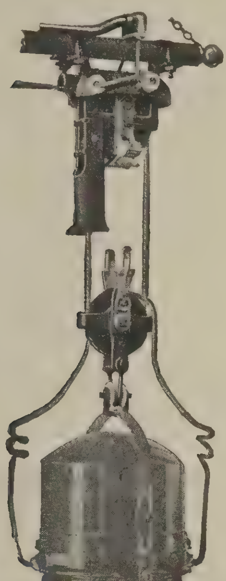
The thin-plate, high-capacity battery developed by the Gould Storage Battery Company, according to the author, has shown outputs as high as 14 watt-hours per pound of plate. It was expected that increased capacity would result from the increased number of plates, but the total number of discharges which could be obtained would be correspondingly reduced. The decreased discharge rate per plate is a factor tending toward an increase of plate life, but this advantage appears to have been offset to some extent by the shedding of active material of usual positive plate compositions. A harder plate composition seemed to present the difficulty of deficient capacity. The mass of the plate is extremely hard originally, and when developed a superficial area only becomes softened, the interior still remaining in the original hard state. The capacity of the plate results almost entirely from this softened outside layer, and, as this wears off in the form of sediment with the continued use of the battery, the surface of the remaining mass of material becomes active. The plate thus retains its capacity as long as any of the hard core is present, and it has exceptional wear-resisting qualities. With a plate of this nature the life can be figured in total amp-hours, instead of the number of charges and amount of overcharge. As is probably well known, this Gould battery is of the Planté type.

The paper was discussed by Messrs. T. F. Mullaney, Walter Quinn, J. M. Gallagher, W. E. Winship, A. B. Lisle, F. W. Smith and R. M. Lloyd.

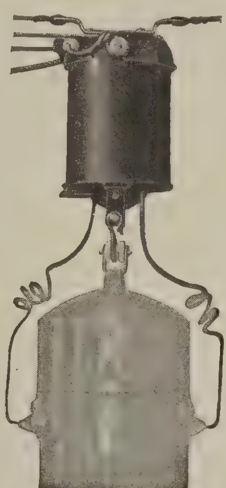
THOMPSON CUTOUT HANGER FOR ARC LAMPS.

One of the most serious problems encountered in lighting erecting floors and machine shops with arc lamps placed high above the floor has been that of providing means for trimming. Usually the old style drop cord with its long hanging lead wires is out of the question on account of the traveling cranes below.

Expensive and dangerous methods of trimming are often employed such as using shop cranes to carry trimmers up to each lamp and trimming from that and even in some cases a permanent platform has been



Casing Removed.



Lamp in Place.

installed high up in the roof truss a little above the lamp and the trimming done from this point. These methods are all expensive, inconvenient, and dangerous to both the trimmer and the workmen below.

A cut out hanger has been developed by the Thompson Electric Co., of Cleveland, which seems to be of merit and should find a wide application in railroad shops and yards.

It is so arranged that when the lamp is lowered it is entirely cut out of circuit and the lamp lowered for the workman's inspection is not in any way connected electrically with the lighting circuit.

Mechanically the cut out hanger is simple, effective and reliable. Two slightly hooked fingers on the pulley block engage with two pivoted dogs on the stationary part of the hanger. These dogs fall into position and catch the two hooked fingers holding the lamp solidly and at the same time serve as an electric switch connecting the arc lamp in circuit.

To lower the lamp it is merely necessary to pull on the cord and then release quickly. This causes the two fingers to slip out of the hanger before the dogs have time to fall back into position. There is no weight on the cord except when the lamp is lowered.

In many cases high power tungsten lamps are used in place of arcs, and as these lamps must be frequently cleaned and occasionally renewed some provision must be made for lowering them. The Thompson hanger is well adapted to this service, as both the locking and unlocking can be accomplished without any jar whatever. A miniature size is made to take care of this class of service.

OLIVER COMPANY PROSPEROUS.

In spite of the ordinarily dull year of 1911, the Oliver Co. declared their annual 6 per cent at a recent meeting of their Board of Directors. A stock holders meeting followed, and all of the old directors and officers were re-elected as follows:

President—F. W. Oliver.
Vice President—E. R. Hoyt.
Manager—T. B. Entz.

RECENT IMPROVEMENTS IN TRAIN LIGHTING CONNECTORS.

The Delta-Star train lighting connector with automatic loop switch or run-around has recently been slightly modified with a view of enabling inspection, repairs, etc., to be quickly made without removing the connector from the car. These changes do not, however, affect any of the spacing distances, mounting holes, etc.

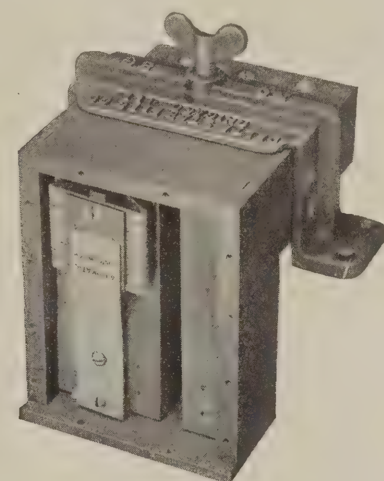


Fig. 1.

As is well known, the Delta-Star connector is provided with a laminated flexibly supported brush switch operated by the regular male connector, the elements being so located that inserting of the male connector automatically opens the loop switch and removal closes it. With this device it is therefore unnecessary for the train men to close the loop switch by hand, as has been required with the non-automatic type. Another advantage of the automatic connector is that in case of

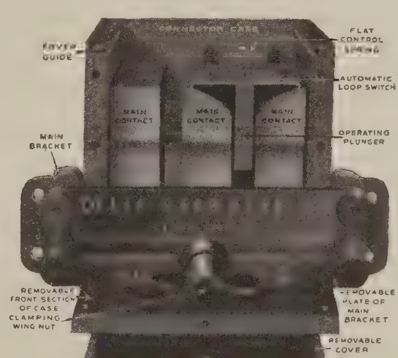


Fig 2.

accidental opening of the circuit only those cars to the rear are without light, all those ahead remaining lighted as the circuit is closed and protected by the automatic switch.

In the Delta-Star connector as now furnished the cover can be removed by taking out one screw, thus giving a full view of and easy access to the contacts, automatic switch, etc. In case it is desired to clean or adjust any part, removal of the front section of the case is easily and quickly accomplished by removing four screws. This feature of quick access to all vital

parts will be appreciated by train men who are called upon to take care of emergency troubles.

One of the most common troubles with train connectors is caused by men breaking off the wing nut screw which clamps the male connector in position and in the usual type of connector it is then necessary to remove the entire element from the car in order to take out the broken screw and put in a new one. This fault has been overcome in the Delta-Star connector by making the main supporting bracket in two pieces, the upper plate of which is removable. With this construction the removal of four screws enables the train men to take off the top plate without disturbing the connector itself, a new binding or clamping screw can then be inserted, and the top plate replaced in position without disconnecting the circuit or taking the connector down from the car.

A great saving in time and expense is thus effected which is very desirable in these days of scientific management, when the management of every railroad is constantly seeking to reduce maintenance and up-keep charges.

L. A. DARLING JOINS REMY ELECTRIC COMPANY.

Mr. L. A. Darling, formerly of the R. G. Peters Manufacturing Company, Grand Rapids, Michigan, has affiliated with the Remy Electric Company, Anderson, Indiana, as Engineer of the Locomotive Headlight Department.

Mr. Darling has long been connected with the engineering profession. At one time he was steam turbine designer for the General Electric Company, Lynn, Mass., and later Assistant Professor of Machine Design, Cornell University, afterward becoming Chief Engineer of the R. G. Peters plant.

Mr. Geo. H. McCormack has resigned his position as Sales Manager and Treasurer of The Opalux Company, to take effect February 10, 1912, and will shortly announce his new connection.

E. C. & M. MOTOR FIELD RHEOSTATS.

The Electric Controller & Mfg. Co., Cleveland, O., has recently placed on the market a new line of motor field rheostats for varying the speed of adjustable speed, shunt and compound direct-current motors. The manufacturers claim the following features of design to be of important value: The construction is fireproof throughout; the face carrying the arms and contacts is of the best quality Monson slate, with beveled edges and oil finish; the resistance units consist of small cast-iron grids insulated with asbestos and wound with resistance wire, these units being carried by the slate and fastened directly to the contacts. The resistance wire has an unusually low temperature coefficient, so that the resistance of the rheostat—for any one setting—does not increase with heating and thereby alter the speed of the motor which it regulates; an ornamental dial plate carrying the words fast and slow indicates at a glance which way to turn the rheostat handle to obtain the desired change in motor speed, by removing the four corner bolts the slate carrying the resistance, contacts and arm can be readily removed from the case; any one resistance unit may be removed and replaced without disturbing adjacent ones.

An extremely interesting and valuable adjunct to these rheostats is what has been designated the field rheostat relay. It is well known that a shunt or compound wound motor should be started from rest with full field strength and, in fact, if the shunt field is weakened to a large extent it may be impossible to accelerate the motor because of insufficient torque, prohibitive sparking at the commutator, or such a large volume of current that fuses and circuit breakers would be blown. It has, therefore, become the preferred practice to return the rheostat handle to position of full field strength every time the motor is started.

The field rheostat relay has been developed to prevent starting the motor with a weakened field.

This relay consists of a magnet coil or solenoid through which passes a steel plunger carrying at its lower end a contact plate, for electrically connecting two contact studs. The magnet coil and the plunger are enclosed in an iron case which serves not only for protection, but acts as a part of the magnetic circuit.

The relay coil is connected in series with the armature circuit of the motor, and the two contact studs are connected to the terminals of the motor field rheostat so that the rheostatic resistance is short-circuited when the contact studs are bridged by the contact plate.

The relay coil is so designed that, when the armature current exceeds a predetermined maximum, the plunger is drawn up, causing the contact plate to connect the two contact studs, thus cutting out all of the resistance in series with the shunt field. This gives the motor its full field strength and consequently maximum torque, enabling it to properly accelerate

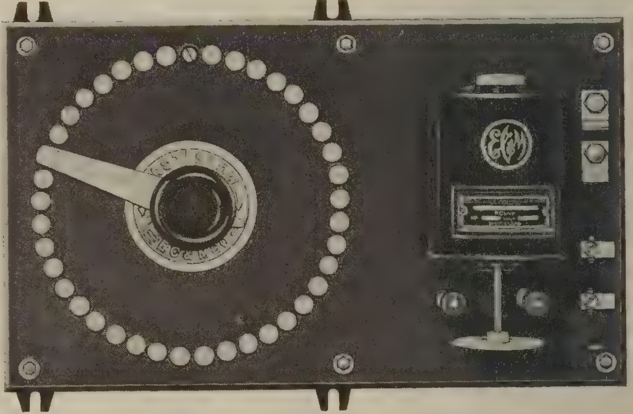


Fig. 1—New E. C. & M. Motor Field Rheostat.

its load. As the current decreases, due to the speeding up of the motor, the relay plunger drops inserting the rheostatic resistance in the shunt field circuit and weakening the field. This cycle of operation is repeated until the motor has been safely brought to the proper speed as determined by the setting of the motor field rheostat.

The E. C. & M. field rheostat relay makes the starting of adjustable speed, shunt and compound-wound motors absolutely safe, no matter what the setting of the motor field rheostat may be. It permits of setting the field rheostat to give the most efficient motor speed for the work in hand and no matter how often the motor is started and stopped, it will invariably run at this efficient speed.

It saves the time of the operator, who no longer has to adjust his motor field rheostat after the motor is safely started.

When this relay is used in connection with the E. C. & M. automatic motor starter or controller, the motor cannot be injured during acceleration.

The E. C. & M. motor field rheostat is furnished either with or without field rheostat relay. It is rated up to and including fifty horsepower, at 110, 220 and 550 volts, and in general will provide for a maximum speed variation of 4 to 1.

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

A. B. C. Car Lighting Series.

It is most gratifying to note the hearty response of the younger men in car lighting work to the announcement of our A. B. C. Car Lighting course. The enthusiastic co-operation we have also received from the more prominent railroad men, of which Mr. Cutting's letter on the page following is an example, compells us to publicly thank you gentlemen instrumental in interesting such a large number of your assistants in taking up this course and becoming regular readers of THE RAILWAY ELECTRICAL ENGINEER.

The possibilities of this course for doing good and helping car lighting men to have a better understanding of the equipment they are operating is alone sufficient cause for a good deal of serious work on our part in making this course a valuable one. It is our most earnest hope that in conducting this course we may continue to receive your frank criticisms and your suggestions as to how it may be improved.

We wish to call your attention particularly to the "Practical Stunts" department of this course, and would request that you encourage your men to send in their ideas. We pay for short articles published in this section usually from $1.00 to $2.00 a piece.

We hope to conduct this, to a certain extent at least, as a correspondence school course and hope that our readers will write us about any points now made sufficiently clear.

Glare from Paper.

For millions of years, the human eye has been trained to perceiving general detail at reasonably great distances, averaging probably several hundred feet at least, and was rarely called upon to scrutinize minute detail at close range.

Consider what a revolutionary change has taken place in the work which the eye must perform today. The advance of civilization of even the past hundred years, which is but a moment of time compared with the countless ages the eye has been in process of developing and adapting itself to the duties imposed upon it, has brought us books and periodicals without end; it has required that children during their development period spend a large part of their time studying and reading books; it has required that a multitude of men spend their entire working day closely applying themselves to work at a desk, usually under artificial lighting conditions. Where the eye of the prehistoric man was constantly changing focus from several feet to even miles, we force our eyes to labor all day long scrutinizing minute detail at a distance averaging 18 inches. It has been said that the greatest invention of modern times was the printing press, but as far as our eyes are concerned this has been the source of much trouble.

The past few years have brought wonderful development in the art of scientific illumination; much effort has been expended, and with gratifying results, in providing uniform and effective distribution of light, and in removing all light sources from the direct range of vision. It seems strange therefore, that such an important phase of the subject as the glare of reflected light from highly calendered paper stock should have been given so little attention.

Mr. J. R. Cravath in his paper on the "effectiveness of light" before the Illuminating Engineering Society, points out that the specular reflection or glare from glazed paper is very much diminished by providing a large number of light sources. This is often impractical on account of existing equipment so the subject of a mat finished paper which will not cause a direct glare to be reflected becomes one of great importance.

Beginning with the present issue the "Railway Electrical Engineer" will be printed on a high grade book stock with a dead mat surface, which entirely eliminates glare and very materially decreases eye strain from reading. We believe that there should be much more attention given this subject of glare from paper by various book and periodical publishers for our eyesight is one of the biggest assets we have. We believe the "Railway Electrical Engineer" occupies the unique position of being the first technical journal to effectively solve this problem.

Electric Traction in France.

A series of experiments are being conducted on one of the French railways in the Pyrenees Mountains to decide upon the most suitable type of single phase locomotive for this service. Experiments are being made with six different locomotives made by six different French manufacturers. On three of the locomotives the compensated series motor is used, on a fourth the repulsion motor with a double set of brushes in short-circuit, and on the last two the compensated repulsion motor with two sets of brushes, one in short-circuit and the other in series with the primary.

We hope to give a short descriptive account of these tests in an early issue.

Association News.

West Oakland, February 15, 1912.

Members of Association of Railway Electrical Engineers:

Noticing the "A. B. C. Car Lighting Series" in the February issue of the "Railway Electrical Engineer" it occurred to me that this would be a splendid opportunity to interest several of the employees of the Southern Pacific Company in the subject of electricity in general and car lighting in particular, and with this idea in view I have written a letter to several of our officials per subjoined copy:

"Superintendents Motive Power, Division Superintendents, Master Mechanics, Master Car Repairers, Signal Supervisors. Gentlemen: The electric lighting of railway passenger cars is rapidly becoming an important feature of railway work and it has been my experience in handling this branch of the business that few of our men, who may be otherwise quite familiar with electrical railway work, have very much idea of car lighting, particularly the axle system, and as it is eventually going to be necessary to locate car lighting inspectors at more frequent intervals than at present it would seem desirable to have some of our young men who are at present employed at various locations on the system familiarize themselves with some of these details which might eventually prove of advantage to them as to this Company.

"We have an engineering society called the "Association of Railway Electrical Engineers" embracing within its membership practically all of the railway electrical men on all of the railroads in the United States, Canada, Mexico, parts of Europe and Australia, and we have an official paper called the "Railway Electrical Engineer" published monthly which contains many articles pertaining to railway car lighting, heating, ventilation, shop motors, and machinery.

"The articles in this paper naturally cover a great variety of subjects but are in the main written in extremely plain language with almost no confusing electrical terms and make good interesting reading for anyone in any branch of the service.

"Commencing with the February issue the paper is going to begin a series of plain talks prepared especially for what it terms "the man in the yards" and the "beginners in car lighting work." This will be known as the "A. B. C. Car Lighting Series" and will be laid out somewhat on the lines of a correspondence school course; a part of every issue being given over to it.

"It has occurred to me that there must be several of our men, particularly the younger ones, who would be interested in something of this kind and I would respectfully urge that you pass this information along to where you think it will do the most good and perhaps we can get some of these young men to subscribe for the paper and commence a study of this subject.

"I have in mind the importance of having our regular car inspectors trained to the extent of noticing the condition of belt on axle light machines and making all such repairs as may be possible and they will no doubt be helped in their understanding of such matters by reading the articles which will appear, provided this could be brought to their notice. Of course not all of such men could be interested but there are no doubt some who would be.

"As before stated the paper is published monthly and is only $1.00 a year and I would suggest that anyone who wishes to subscribe should commence with the January issue as it contains many articles of particular interest. The address is: Edward Wray, President Wray Publishing Company, 106 N. La Salle St., Chicago, Ill.

"I am asking Mr. Wray to send each of you a sample of copy of the paper.

"I might also say that there are no doubt several of the men who are engaged in electrical work with this Company who would be eligible for membership in the Association, the dues being only $2.00 a year, and if anyone cares to identify himself with this rapidly growing engineering society I should be pleased to hear from them and will send them application blanks.

"Thanking you for any assistance which you may be able to give in this matter, I remain,

Yours sincerely,

(Signed) E. M. CUTTING."

I am not advancing this idea as anything particularly new but it has occurred to me that many of our members, particularly the Senior Actives, could and I think should inaugurate a rather extensive campaign among the railway employees, particularly the younger ones who no doubt would be interested in this subject.

There are in all probability several of our men working in the signal department who have more or less to do with general lighting and shop motor work who would be eligible to membership in our Association, some of whom might be induced to join if the matter were presented to them in the proper light.

Yours very truly,

E. M. CUTTING,

Past President.

Car Lighting Club Ladies Night.

The formal dance given by the club at its February meeting in honor of the ladies was the biggest kind of a success from the first glad hand of the "reception committee" to the, "Home Sweet Home," at the finish.

Do you remember how the wind whistled around the corners that night and piled up a young snow drift inside of your coat collar? It overturned wagons, blocked traffic generally and had the railroads all bluffed to a standstill; but not so the Car Lighting boys and their fair ones. When the blizzard was at its worst some of the wise heads predicted that we would have about three couples there, but they made a bad guess. We, as general scribe knew it was our moral duty to report the number present as per the rules and regulations of the Amalgamated Association of Country Editors, so detailed one of our staff with a counting machine to get the score, but it was too much for him.

It was just the right size of a crowd, however, not so many as to crowd the floor, yet enough to make life interesting; and the music—with the rich mellow tones of the harp and cello and the other instruments accompanying, who wouldn't enjoy a dreamy waltz on an elegant floor.

Oh yes! and the eats—we didn't dreamy waltz all the time, but would occasionally repair to an adjacent parlor to partake of the good things our entertainment committee had provided.

This, the first of our social functions was such a brilliant success that it seems advisable to continue these informal affairs and we will undoubtedly have another before long.

Now if you were detained from attending this little dance by the extra amount of trouble on your equip-

ment due to the severe storm, well and good—we just hope for better luck next time, but if you deliberately got cold feet and decided to stay home where you could keep your toes warm at your own fire side, permit us to tell you that you passed up one of the times of your life.

Next Meeting of Car Lighting Club.

The subject of March meeting of the Club will be "Train Lighting In Europe." The paper on "Electrical Lighting of Railway Trains in England" published in the February and March issues of The RAILWAY ELECTRICAL ENGINEER by Roger T. Smith, Elec. Engr., of The Great Western Railway of England, will be discussed.

The secretary tells us that he has some communications from other English, German, Swiss and French car lighting men so this ought to be a good live meeting and one from which we should get some good ideas for improving our practice in this country. Read over the paper by Mr. Smith and come to the meeting loaded with criticisms and suggestions.

The April meeting of the club will be "Planning and Equipping of Railroad Shops," by Geo. W. Cravens.

May—"Troubles and How to Shoot 'em," discussion opened by H. G. Myers. If you can't come to the meeting yourself, send your troubles to Mr. Myers, care Santa Fe, Chicago, and he will bring them up at the meeting.

March meeting will be held as usual the third Wednesday, March 20, at 6:15 P. M. at Kuntz-Remmler's Restaurant, 424 So. Wabash Ave., Chicago.

Electric Lighting of Railway Trains in England

By ROGER T. SMITH, Electrical Engineer, Great Western Ry. of England*

(Continued from February issue.)

Brake-Vehicle Method.

With the exception of through coaches transferred from main to branch lines, every train on the Great Western Railway has at least one brake-vehicle controlling it for traffic purposes; and all coaches which leave or join a main-line train on route are either brake-vehicles themselves, if detached or attached, it

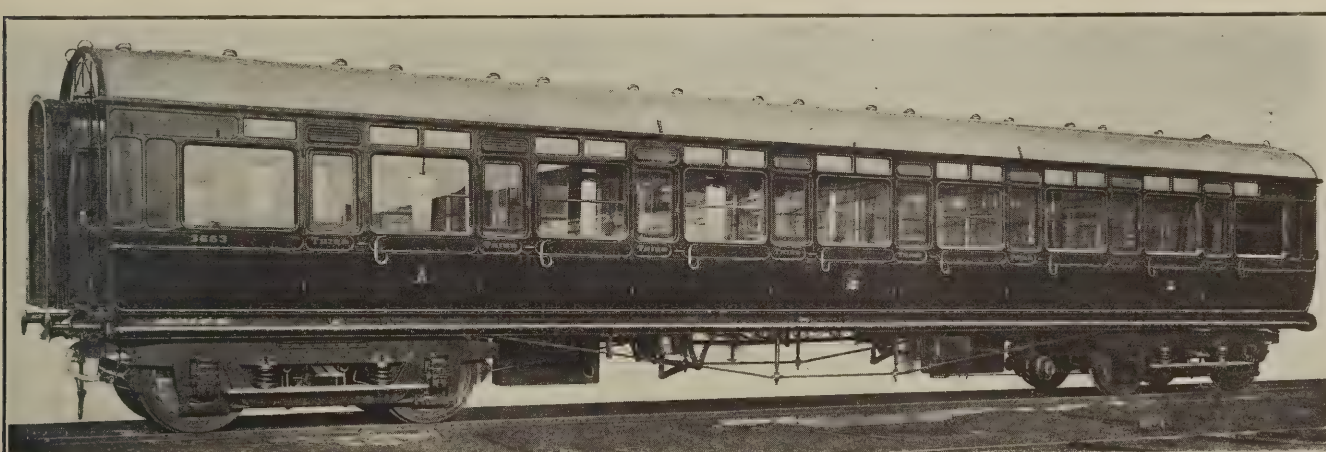


Fig. 9. English Coach, Showing Location of Generator.

is controlled by a brake-vehicle. If, therefore, every brake-vehicle is equipped with a generator and battery, while the remaining coaches are wired only and if on every coach through wiring and couplers are provided, designed to connect all coaches together electrically, a less costly method of lighting trains is assured, as compared with the equipment of every coach on the self-lit method.

The size of the equipment is chosen to meet the requirements of modern stock, and excursion-trains being generally made up of smaller stock, the standard equipment on two brake-vehicles is sufficient to light an excursion-train of twelve coaches inclusive of the brake-vehicles themselves.

The working out of such a system to meet the actual conditions of traffic is not so simple and straightforward as the statement might lead one to expect.

From the traffic point of view the application of the brake-vehicle system to all passenger-stock is limited by the breaking-up of trains for branch connections and through coaches, and it is for this reason that one-third of the main-line stock would, if electrically lit, be self-lit. Further, the adoption of the method divides the rolling stock into two groups, adding considerably both to the difficulty and expense of shunting, marshalling, and distributing coaches to meet traffic requirements. Beyond the extra time taken in coupling and uncoupling through connections, very little inconvenience results from the through wiring, since the couplers are beside the steam heating and vacuum-brake connections, and the coupling and uncoupling is done by the same staff.

On the other hand, there is a very substantial reduction in capital cost which, when the system can be taken full advantage of as in the local and branch stock, amounts to about 35 per cent of the cost of self-lit equipments, with a reduction in maintenance- and working-costs of 40 per cent.

Its real advantage, however, is increased reliability. Apparatus will fail, and since in practice there will be always several self-lit coaches and brake-vehicles in any train with their generators in parallel, the failure of one dynamo or the loss of a belt need make no difference. With a purely self-lit system the failure of any one piece of apparatus may put that coach in darkness.

*Paper presented before Institution of Civil Engineers, London, England, Feb. 1912, by Roger F. Smith, Elec. Engr., Great Western Ry. of England.

In order to secure this reliability to its fullest extent, not only would every sleeping- and restaurant-car be provided with through wiring and couplers to put its generator and battery in parallel with the rest, but every self-lit coach would be so through wired. This arrangement provides such a margin in generating-power and storage-capacity as to allow of 30 per cent of the equipments being out of use on a normally-formed train without an inconvenience. This increase in reliability is of greater importance to the railway than the saving due to fewer generator-coaches.

In adidtion to the apparatus required to supply the lamps this brake-vehicle system makes further specific demands. The dynamo, or generator, has to work in parallel with other generators and must therefore have shunt-wound fields. It must be capable of having its output adjusted by some simple means between wide limits, so that if an equipment has for a time to light only the brake-vehicle as a self-lit coach, it can be readily adjusted to an output of, say, 60 per cent of full load. Finally, and most important of all, it must be rigidly limited in output. If three generators and batteries are working in parallel on one train and the belts of two come off, the third generator will try to carry the whole load; should it be overloaded 200 per cent in the process, the protecting fuse ought to blow. If not protected, the dynamo will burn out. This not only leaves the train dependent upon its batteries alone, which may or may not fail, but it is unlikely that the failure of that dynamo will be noticed. A carriage-examiner will generally notice a lost belt and report it to the next stop, but he cannot detect a blown fuse during a few minutes' examination. If, then, the reliability of the brake-vehicle system is to be assured, the output of the dynamo must be limited to a certain safe maximum.

As far as could be discovered, only one system of train-lighting made in England fulfilled the necessary conditions required for brake-vehicle equipment, first with regard to the limited maximum output of the generator, and secondly with regard to the regulator. The Leitner dynamo in its standard form already possessed the essential limitation of output, since the generator could work with its terminals short-circuited; at the same time, the system possessed a regulator fulfilling most of the conditions stated to be necessary.

Summarized, these conditions are: limited maximum output of the generator; easy adjustment of the output over a range of 40 per cent.; parallel running between generators of different outputs; cut-in cut-out switch to act as a reverse-current circuit-breaker; lamp-voltage control within 2½ per cent.; battery-charge control; battery-overcharge prevention; and, finally, battery when fully charged floating on the lamp-load. Since the first experimental train was equipped, such of these features as were lacking have all been added to the Leitner system. Mr. Leitner worked indefatigably at the problem, modifying apparatus where necessary or designing new apparatus to meet the requirements.

To test the brake-vehicle method of train-lighting the Great Western Railway decided to equip a six-coach corridor train. The specification for the equipment having been drawn up, the contract was signed in the summer of 1908, and a complete experimental train was running in March, 1909. The arrangement of the coaches in plan is indicated in Fig. 10, Page 233. The lamps were enclosed in central fittings to suit the clerestory coaches, each fitting containing three lamps. This type of fitting is not recommended, as it does not give the advantage in distribution obtainable from spacing small units of light over the roof, and now the arrangement shown in Fig. 1 is adopted, as already described. A diagram of the wiring and apparatus is shown in Fig 10, all but essentials being left out.

It is proposed briefly to describe the equipment and working of this train, and then to give the initial cost of installation, the working and annual costs, and, finally, some account of the experiments made to determine the locomotive power debitable to the electric lighting of a train.

Equipment of Experimental Train.

The six coaches were lit by a total of one hundred and forty-two 10-candle-power tungsten lamps, giving a total rated input of 1,700 watts. The actual measured input during the experiments was 1,683 watts—that is to say, 76.5 amperes at 22 volts, or a little under 1.2 watts per rated candle-power.

The two third-class brake-vehicles were equipped with Leitner series VI generators, which at that time were rated at 45 amperes each. They are now rated at 50 amperes, although this output can be raised to 60 amperes by adjustment. The five coaches supplied direct by these two dynamos, of a rated output of 90 amperes, had a lamp load of 62.5 amperes, so that there was a rated generator margin of only 27.5 amperes over and beyond the lamp load for battery-charging. This was purposely made an insufficient margin for charging two 180-ampere-hour batteries, in order that the assistance of the self-lit coach in keeping the brake-vehicle batteries in condition could be thoroughly tested. The sixth coach was self-lit, and being already equipped on the Leitner system was taken out of traffic; it was modified to suit brake-vehicle conditions, and though never slipped, it was worked as a detachable coach when and as desired. The self-lit equipment included a 180-ampere-hour battery and a 45-ampere generator, so that there was a rated dynamo-output to the whole train of 135 amperes and a lamp-input of 76.5 amperes, giving a margin over the lamp-input of 58.5 amperes for charging the three batteries. This margin was not sufficient to charge them at the 8-hour rate with all lamps on.

As already stated, repeated experiment with a watt-hour meter, specially designed to be uninfluenced by vibration, has shown that in order to keep a battery in good condition the watt-hour input to the lamps should not be greater than 60 per cent. of the watt-hour running in service. This assumes that the capacity of the battery is not less than the rated output of the generator for 3 hours. In the six-coach train, assuming all lamps alight and no daylight running, the lamp amperes at 22 volts is 46 per cent. of the dynamo amperes at the average charging pressure of 27 volts. For a slow, stopping service the automatic switch connecting the dynamos to the battery may be closed only for half the time that the lights are burning and in such a case the input to the lamps would be 90 per cent. of the dynamo-output.

It will be seen, therefore, that this train was equipped to test the brake-vehicle system under limiting conditions. The six-coach train had a generator capacity sufficient to keep the batteries in condition, had their capacity been equal to the rated output of the dynamo for 3 hours, i.e., to 405 ampere-hours. Actually their capacity was 540 ampere-hours, and the generator capacity with the given lamp load was not sufficient to keep the batteries healthy without day-

light running. For a suburban slow service each dynamo output had to be increased to 60 amperes, in order to charge the cells properly. . No margin for failure of any of the equipments was allowed for, so, that, if with all the exigencies of traffic the equipment worked without failure and kept the batteries in good condition, the method could be pronounced successful.

Leitner Apparatus.

It is necessary to say something about the particular apparatus comprising the Leitner system. The variable-speed generator ensures approximately constant voltage at all speeds and outputs above cutting-in speed by connecting the shunt field through the armature to a pair of axiliary brushes which bear on electrically opposite sides of the commutator, and are, in the case of bipolar machines, approximately at right angles to the main brushes. Main and auxiliary brushes move as one system, and the whole system is given a forward lead. The field-current may therefore be said to pass through the armature twice, in directions electrically at right angles to each other. When the dynamo revolves slowly the pressure across the auxiliary brushes is added to that across the main brushes, so that the field-current is large and the machine builds up quickly. As, with increased speed, armature-reaction distorts the magnetic flux in the direction of rotation, the effect of the auxiliary brushes first diminishes to zero and then reverses as their polarity reverses. The effect of these brushes is then to oppose the main brushes, and the field-current is reduced. By this means the voltage of the machine can be kept practically constant for all speeds from, say, 500 to 2,000 revolutions per minute, though the inherent regulation of the machine will allow its voltage to rise independently of speed when charging a battery.

By altering the lead of the brush combination relative to the axis of symmetry, the maximum output obtainable from the machine can be altered permanently. Increasing the lead increases the maximum output, and decreasing the lead decreases the maximum output. This is most conveniently done through a double-scroll cam attachment to the brush-gear. By rotating the scroll the lead is altered equally for both directions of running. By means of this simple adjustment, which reduces the forward lead of the brush combination from an angle of, say,, 10° to zero, a range of output of 100 per cent. to 60 per cent. of full load can be secured. The angle of 10° is the best lead at which to work under normal conditions. If, however, a lead of 17° is given for full load, then by moving back the brushes to the axis of symmetry the output can be reduced to 40 per cent. of the maximum. In Fig. 2, is shown the output in amperes and the field-current, together with the corresponding voltage of Leitner dynamos of the 100-ampere and 50-ampere size, for the whole range of speeds and with one definite value of lead.

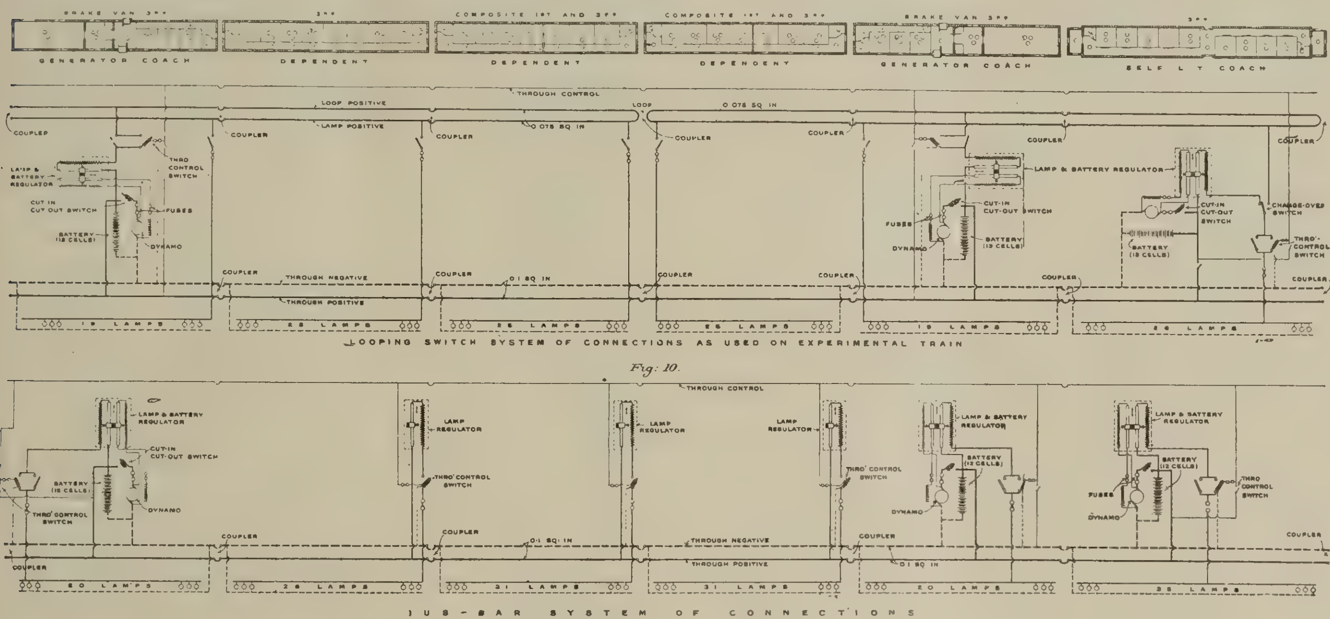


Fig. 10. Train Line Connections.

The auxiliary brushes further provide the essential feature for automatically-controlled dynamos working in parallel, namely, an absolute limitation in output. Increase in armature-current without increase in speed will increase the armature-reaction, producing distortion of the field-flux. There is a point at which increased reaction decreases the field by means of the auxiliary brushes at such a rate that no greater output can be obtained. The terminals of the Leitner machine may be short-circuited, and it is therefore safe to use different sizes of machines of this type in parallel with varying battery-capacities and lamp loads.

On the first journey made by the experimental train, all lamps being on, two out of the three dynamos were purposely put out of service by breaking the circuit of their respective fields. The third machine continued to work at full load, while the remainder of the lamp load was taken by the batteries.

The cut-in cut-out switch Fig. 12, is actuated by an armature of the shuttle type rotating in two field-windings both in series between dynamo and battery, one winding of fine and the other of coarse wire. The armature-winding is connected across the battery. The fine series winding is short-circuited by the coarse winding when the switch is closed. This switch acts as an instantaneous reverse-current circuit-breaker to protect the dynamo-armature from the battery.

It is not proposed to give a technical description of the regulator used with the Leitner system, more than to say that all regulation is controlled by an accurate voltmeter switch of the beam-balance type, the pull of solenoid acting against an adjustable control spring. Any increase in voltage above the normal makes a

contact on one side of the beam-balance, while any decrease makes a contact on the other side. The contacts work relays, and the relays supply current to move, through a small motor and gearing, a slider on four rows of variable-resistance contacts.

One variable resistance is in series with the lamps, each of two others in series with one half of the dynamo-field, and a fourth is in series with the voltmeter-coil itself. One slider moving over all four rows of contacts adds or substracts resistance simultaneously in each circuit, each section of the slider being insulated from its neighbor or neighbors on adjacent contacts.

If lamps are on, the voltmeter switch is always across the lamp-circuit; if lamps are off, and the battery is charging, it is across the battery. In the latter case increase in battery-pressure causes the voltmeter switch, in moving the slider over the resistance-contacts, not only to add resistance to the field-circuit, but also to add resistance to its own circuit, so that it sets itself automatically to balance at a higher voltage after each movement. By this means, together with the self-regulation of the dynamo-voltage responds to the increasing battery-pressure as charging proceeds, but at a decreasing rate, so that, as shown in Fig. 2, the the charge is tailed off. At a given voltage, for which the voltmeter can be set by altering the tension of its control-spring, the regulator diminishes the strength of the field so as to reduce the armature-current to zero.

With lamps on, and the battery on charge, the voltmeter switch adds no resistance to its own circuit, this resistance being short-circuited; but as the battery-pressure rises it adds resistance at the same time in the lamp-circuit and in the dynamo-field circuit, and therefore incidentally in the voltmeter-circuit, the voltmeter being the equivalent of a lamp. Should the battery-pressure for the twelve cells rise to, say, 30 volts, corresponding nearly with full charge, the 8 volts difference between the battery- and the lamp-pressure is made to switch-in (through a relay) a certain definite resistance to the dynamo-field variable resistance. This is equivalent to lengthening the scale of the variable resistance, thus gaining a further range for regulation. By this means the charging current is gradually reduced until, finally, floating conditions are produced, the dynamo taking the entire lamp load.

First, by adjusting the control-spring on the voltmeter switch, or secondly, by adjusting the calibrating resistance in series with the voltmeter, or thirdly, by temporarily short-circuiting the whole of the variable resistance either in one or both halves of the dynamo-field (which can be done by two switches, one for each field, provided on the regulator), the efficiency and duration of the battery-charge can be altered at will between all practicable limits. By this means an over-discharged or sulphated battery can be specially treated for one or more journeys.

Wiring.

As shown in Fig. 10, two main cables, a through positive and a through negative, each 0.1 square inch in copper section, are run throughout the train. Each generator-coach dynamo and battery is in parallel between them. Two more positives are run throughout the train, of 0.075 square inch section. The outer or "loop positive" is connected with the generator and battery through the lamp-resistance of each regulator, this lamp-resistance being capable of regulating the lamp-voltage and carrying the current for three coaches. The lamps are in parallel between the inner or "lamp positive" and the common through negative, and where pairs of coaches are coupled together, provision is made to connect the loop positive with the lamp positive between any two coaches. The result is that for five coaches the two brake-vehicle generators and batteries are in parallel, each regulator looking after its own battery and dynamo as well as all the lamps between itself and the loop, wherever this may be made.

The loop is an old arrangement for obtaining uniform drop in voltage at all lamps supplied through the loop, while its presence is necessary to prevent the two regulators working in series.

The sixth or self-lit coach has its dynamo and battery in parallel with the other dynamos and batteries, but the lamp-regulator affects that coach only. For this coach the change-over switch shown in Fig. 11, serves, for experimental purposes, to connect the lamp load either to its own regulator, or to the lamp positive, in which latter case the lamp-voltage throughout the loop is regulated by the nearest brake-vehicle regulator.

Through control-switches enable the guard in either brake-van to switch on all the lights in the train, provided the hand-switches shown in each coach are closed. They are only put in for experimental purposes and are left out in actual coach-wiring. The lights of all the coaches fed by a generator up to the loop can also be put on by the hand-switch opposite the through control-switch in each brake-van.

Through wiring, of paper-insulated copper cable, braided overall on the "indestructible" process, is carried in wood casing on the roof and brought down through junction-boxes to coupler-sockets fixed just above the sole-bar. Mr. Langdon, in his Paper already referred to, shows that one half of the coupling must be the exact duplicate of the other half. In the experimental train there is a socket on each coach-end, the sockets being electrically connected by the five necessary cables with a plug at each end. These cable-couplers are therefore detachable, and one of them has the necessary loop made at each plug. This looping coupler, painted a distinguishing color, loops the lamp positive between any two coaches as desired. This arrangement, though quite suitable for an experiment, is not suitable for service. One end of the coupler-cables must be attached permanently to the coach, and the most satisfactory arrangement seems to be to have two coupler-cables between adjacent coach-ends, one on each side of the gangway-bellows in corridor stock. The plug of one coupler fits into a socket on the next coach, and by thus staggering coupler-sockets and plugs the connections are always right, whichever way the coach is turned. This arrangement duplicates the couplers, which are the parts most liable to injury in the rapid marshalling of coaches, and such duplication seems not only advisable but necessary.

In trains other than the experimental train equipped on the brake-vehicle system on the Great Western Railway, each junction-box, connecting the through wiring on the coach-roof to the wiring of the coupler-sockets, would contain a looping switch. This switch is worked by a hand-lever from the coach-vestibule in corridor stock, and externally from the platform in non-corridor stock, and the guard makes his loop as nearly as possible midway between each pair of generator-coaches after the train has been made up.

Equipped as described, the six-coach experimental train made its first trip on the 16th March, 1909, and went into regular traffic on the next day. Since that

date with one break it has run continuously in both fast and slow services.

Only one alteration has been made in the equipment since the train first started. By a curious mistake, clearly seen on the diagram, the loop positive and lamp positive were made 0.075 square inch in section, while the through positive was made 0.1 square inch in section. These dimensions should have been reversed, since the loop cables carry the whole lamp load and the through cable only interchanges current from one brake-vehicle to the other. In consequence, the drop in voltage between the regulator and the lamps was too great, and a cell was added to each battery, making thirteen cells, to compensate for this drop.

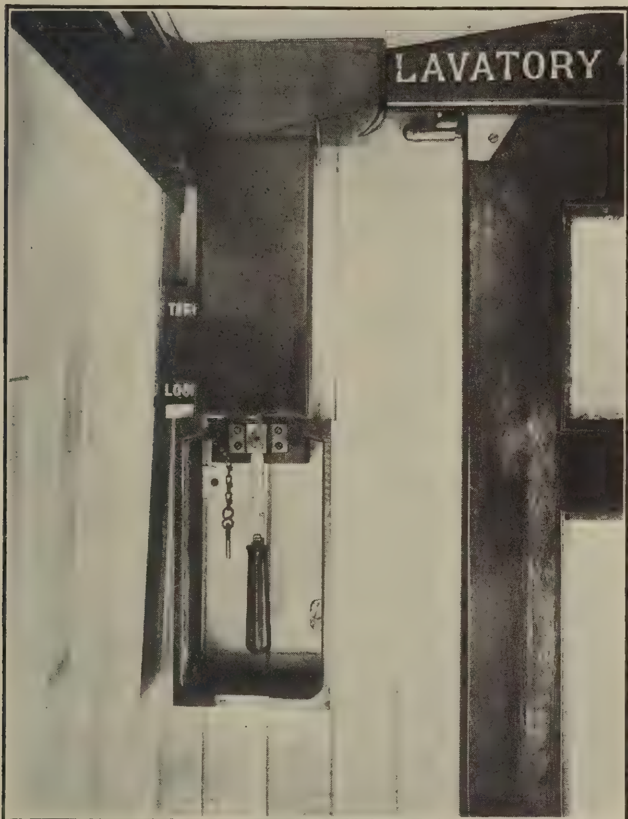


Fig. 11. Loop Switch.

After the experimental train had been run for a few weeks, two five-coach trains, running between Paddington and Fishguard, the electric-lighting apparatus of which had worn out after 10 years' service, were equipped on the brake-vehicle method. They were put into service, one in July and the other in August, 1909, and have run ever since. One of them was regularly divided at Cardiff on the down journey for the insertion of a gas-lit dining-car, the loop being made at each end opposite the dining-car. Under these conditions there is no through wiring connecting the brake-vehicle equipments, so that the element of duplication in case of failure is gone. The trains have run without failure.

Two new trains required for the service between London and Fishguard in connection with the Cunard boats were lit electrically on the brake-vehicle method and put into service in sections between September and December, 1910. The apparatus was supplied to a complete specification. Owing to the large number of lamps in each train, namely 537, corresponding with a lamp load of 320 amperes the brake-vehicles alone could not conveniently carry the necessary equipment, and out of twenty coaches, eight were made into generator-coaches each equipped with 100-ampere dynamos and 210-ampere-hour batteries. Twelve coaches were dependents equipped with lamps and through wiring only, while six were self-lit coaches —four dining-cars being equipped with dynamos and batteries of the same capacities, and two luggage-vans being equippped with 50-ampere dynamos and 90-ampere-hour batteries. All equipments work in parallel. In Fig. 10 is shown the formation of a full train, and the number of different combinations in which the coaches can be arranged for various sizes of train is partly indicated by the brackets.

There has only been one failure since these trains were put into service—due to the contact of a looping-switch coming loose. This put three coaches in darkness for 10 minutes on two occasions.

Two other four-coach trains, intended for local service in the Birmingham district, have been equipped on the brake vehicle method. These are set or block trains, and the couplers and sockets have been dispensed with, the through cables being connected between each coach by eye sockets bolted together, and each joint insulated. Other local set trains are in course of equipment, but since their composition may be varied, a simplified form of coupler and socket, as compared with that described for main-line working, will be used for connecting the through cables.

Experience with these trains has shown that the looping arrangement has serious disadvantages. Mr. Langdon used a loop, but not quite with the same intention, the primary object of the loop in the brake-vehicle method being to enable one regulator to control one battery and generator, and the whole of the lamp load supplied directly by that combination. To control a lamp load of 100 amperes requires a larger regulator than is quite convenient, and there is, moreover, a 10-per-cent. drop in the loop and lamp positives. The looping-switches, two on each coach, are a traffic difficulty, for in corridor trains they have to be worked by the guards and instructions must be issued for their use. These instructions must be simple, and no mistake has ever been made on the Cunard trains where they were first adopted; but if the looping-switch could be dispensed with entirely, not only apparatus, which may fail, and in any case requires maintenance, but also a traffic instruction are saved.

In Fig. 10 is shown diagrammatically the experimental train with through wiring on the brake-vehicle method equipped on the bus-bar principle. The number of lamps in each coach corresponds with the standard arrangement introduced since the experimental train was first equipped. This arrangement is shown in Fig. 1. Two through positive and negative cables, and a third wire for through control, pass through the train, with duplicate couplers between each coach. These through cables will always be supplied at battery voltage, and act exactly like the bus-bars of any ordinary direct-current switchboard. Every coach, whether generator, self-lit, or dependent, must have its own lamp-voltage regulator, while generator-coaches have, in addition, a regulator for the dynamo.

The wiring arrangement is obvious and, without either lamp-regulation or the principle of working apparatus in parallel, is already in use abroad, so that it would have been adopted from the first if two years ago the cost of a separate lamp-regulator in each coach had not seemed prohibitive. Mr. Leitner has been designing apparatus to meet the requirements, and at the present time it can be said that the extra cost of lamp-regulators in each dependent coach is almost exactly balanced by the saving in through

wiring and looping-switches by the use of the bus-bar system.

If for brake-vehicle train-lighting the bus-bar principle replaces the looping-switch principle, all traffic-instructions for making the loop, and for inserting coaches which have no through wiring between two loops, are avoided; the voltage loss beyond the lamp-regulator is reduced to about 2 per cent.; the through wiring can be smaller in section than the looped and lamp positive, since a drop of at least 15 per cent. is permissible; and last, but not least, any coaches on a foreign railway, equipped on a system which can fulfil the conditions of brake-vehicle lighting, can be coupled up and share in the lighting, provided they use a twelve-cell battery.

The need of electric train-lighting in the immediate future is the cheapening and simplification of apparatus, especially regulating-apparatus, and there is certainly a use for a cheap lamp-voltage regulator costing not more than $25.00. It will be noticed in Fig. 11, that in addition to the lamp-voltage regulator, a through control-switch for switching lights off and on from either brake-van is required in each coach.

At the present time no reduction can be made in the initial cost of equipping a six-coach train, owing to the use of the bus-bar in place of the looping-switch principle of through wiring; but from both the traffic and the engineering point of view it is preferable, and will lead ultimately to reduction in initial cost. The method further permits, if desired, of the use of a battery on every coach, greatly increasing reliability.

Costs of Electric Lighting.

The initial cost of equipping the experimental train on the looped positive principle as shown in Fig. 10 is given in Appendix I. This does not include the cost of all extra fittings and conveniences for measurement and for observation of the equipment. All the equipment was mounted inside the brake-vehicle, with the exception of the three dynamos and the battery of the self-lit coach, and the initial expenditure came to $4,020. This does not, however, include the cost of equipping the self-lit coach taken from traffic, though it does include the alterations necessary to fit it with through wiring, couplers, and fittings for measurement. The cost given in the Appendix is the cost, at 1910 prices, of completely equipping such a train for actual service inclusive of looping-switches and of duplicate couplers and sockets in every coach. For the bus-bar equipment the cost is the same. In the experimental train the cost of the special arrangements made for observing batteries and regulators in the brake-vehicles, and the facilities for connecting up measuring-instruments was $540.

In the estimate of initial cost the charges are inclusive of all material and labor employed by the locomotive department in wiring and adapting coaches for electric lighting; they also include material and labor for housing and suspending batteries, regulators and switches, as well as the cost of dynamo-suspension and the provision and fitting of axle-pulleys. Proper factory charges have been added to the prime departmental cost, so that the figures given represent real costs and not out-of-pocket expenses.

It is not suggested, however, that these prices would cover the equipment of a six-coach train ready for service if only apparatus sufficient for such a train were ordered and erected by a staff not thoroughly skilled in such work. With apparatus capable of complete automatic control, such as has been described, the prices given are on the assumption that several hundred equipments would be ordered in the course of a year. Under such conditions they amply cover all costs at the present time, and prices of raw material remaining the same, certain items may be expected to decrease in cost very considerably.

The annual costs of lighting electrically such a train as shown in Fig. 10, are given in Appendix II. These annual costs are divided into:

Working costs, which include—
- Battery-maintenance and renewals.
- Dynamo- and regulator-maintenance.
- Lamp-renewals.
- Maintenance of fittings, through wiring and connections, and lamp-wiring.
- Locomotive-charges for power and for haulage of extra weight of the equipment.
- Interest on initial expenditure.
- Sinking fund for reproduction of capital.

Working Costs.

These are the result of only two years' experience of maintenance, but that period includes the maintenance of a fair proportion of apparatus which has been in service for various periods up to 10 years, and the figures given are based on maintaining and renewing batteries and dynamos after many years of service.

Battery-maintenance and plate-renewal charges are the actual cost of maintaining the battery-plates, electrolyte, and lead-lined boxes, and agree very well with experience in maintaining and renewing central-station batteries working under more severe conditions than obtain in the present case, where 10 per cent. per annum on the initial cost is generally found sufficient. This is only true for train-lighting batteries, provided the charging is completely looked after by such automatic apparatus as has been described, and such a percentage would not apply to batteries which may be habitually over-charged. The exact proportion of the 10 per cent. per annum which should form a sinking fund for plate-renewals has not yet been established, but a basis of 7 1-2 years' life has been taken for all plates, both positive and negative, since batteries can be bought on a 5 years' guarantee. The plates constitute about two-thirds of the value of the whole cell, and the old plates and lead sludge when sold have about 30 per cent. of their original value. The actual cost to the Great Western Railway of maintaining about 3,600 cells during 1909 and 1910 represents 8 1-2 per cent. of their initial cost, and includes a fair proportion of plate-renewals to batteries more than 5 years old.

Dynamo- and regulator-maintenance is represented chiefly by belt-renewals and the repair of small mechanical troubles with dynamos, brush-gear, and brushes. The Leitner regulator, in 2½ years' experience, is the cheapest piece of apparatus to work, the cost of maintaining some hundreds of them averaging between $0.75 to $1.00 per regulator per annum, provided the balance-beam contacts on the voltmeter switch work in mercury cups. Regulators require cleaning about every 14 months, and that should be the extent of their maintenance cost.

Lamp-renewals are quite reasonable now that manufacturers have recognized that the tungsten train-lighting lamp with a small bulb needs a more perfect vacuum than the ordinary tungsten lamp in a much larger bulb. On the Great Western Railway the time of lighting averages 950 hours per annum for the whole stock. The useful life of the 13-watt, 10-candle-power tungsten lamp is about 900 hours, and during the whole of 1910 lamps were lasting for 12 months before renewal. It is, therefore, not con-

sidered economical to run lamps at a lower efficiency than 1.3 watt per candle, as 12 months is a quite long enough life for a glow-lamp.

The maintenance of wiring and fittings is rather high owing to fuse-renewals. Rigid inspection of fuses is necessary, since any screwed contacts will

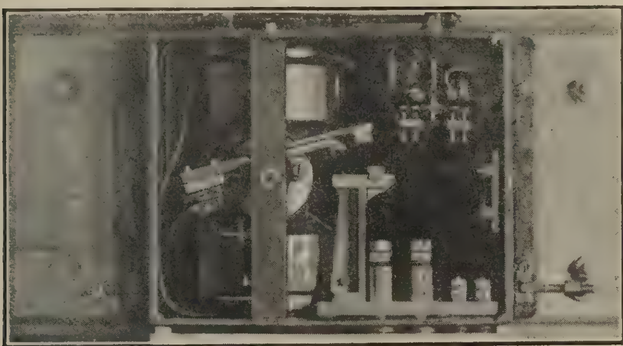


Fig. 12. Automatic Switch.

work loose from vibration. If duplicate fuses are ready in every switch-box the fuse-wire may be soldered to its fuse-clamp and unsoldered when the fuse is returned to the shops for renewal of the wire. It is a wise plan to change all fuses every month on a regular routine, to ensure reliability.

These charges constitute the out-of-pocket expenses to a railway for maintaining train-lighting. Over the 2 years that the experimental train has been in serv-

Fig. 13. Train Line Connectors Located Above Floor Line.

ice they have averaged, as shown in Appendix II, $37 per coach per annum. This is, in so short a time, naturally exclusive of battery-plate renewals, but is inclusive of daily inspection of the train. The cost of extra battery-charging while on the Windsor service, which was approximately $90, has been excluded.

For not less than 500 coaches, equipped on the brake-vehicle method with generator-, self-lit, and dependent coaches much the same ratio as they are in the experimental train, the annual out-of-pocket expenses, averaged over the entire stock, should not be higher than $30 per coach per annum. If all coaches were self-lit on some properly regulated single-battery system the cost might be expected to be $45 per coach per annum.

Where, on the other hand, as in the made-up trains method can be pushed to its logical conclusion, each brake-vehicle lighting four or five dependent coaches, the average maintenance per coach can be reduced to between $15 and $20 per annum. In all these cases battery-regulation and lamp-regulation is assumed.

Locomotive Charges for Power Generation.

To determine the locomotive-costs debitable to electric lighting is not an easy matter. It cannot be determined by running a train first with and then without the lighting apparatus at work, and measuring the draw-bar pull by means of a dynamometer-car between the locomotive and the coaches, since with any economical system the power taken should be less than 5 per cent. of the locomotive's output, and the dynamometer-car can hardly be said to have an accuracy of a much higher order than 5 per cent. Two journeys by the same train, over the same section, and run by the same locomotive under approximately the same conditions, usually differ by much more than this percentage.

A separate determination of the efficiency of the dynamo under train-lighting conditions as to speed, type of transmission, and gear-ratio must, therefore, be made; the results being used in conjunction with dynamometer-car tests of the lit train.

In 1906 very complete tests of the performance of the 50-ampere size, of Leitner train-lighting dynamo were made at Faraday House and further tests of the machine, both at Faraday House and when forming a coach-equipment in a Great Western train, were made by Mr. Henry M. Sayers. The only difference between the machine tested and the three machines used on the experimental train was that, on the brake-vehicles, the dynamos had ball bearings in place of parallel oil-bearings. The self-lit coach was equipped with a sister machine to that tested. The results of Mr. Sayers' tests on the complete equipment are shown in Fig. 12, the measured input to the belt on the axle-pulley and the measured output from the dynamo being given, together with the no-load losses (which are approximate only). The efficiency-curve inclusive of transmission-losses, belt-slip and dynamo-losses is also given. These values are plotted with train-speeds up to 85 miles per hour, which speeds correspond with a gear-ratio of 3 to 1 as used on the experimental train, and to standard 43-inch wheels. In Fig. 8 is shown the locomotive draw-bar pull necessary to produce the normal dynamo-output curve given in Fig. 2, for the 50-ampere dynamo; it corresponds with conditions and gear-ratio of the experimental train. In both cases the distinctive feature of the Leitner dynamo is seen, namely that the maximum demand upon the locomotive is at low speeds, and that as the speed increases the draw-bar pull decreases.

Dynamometer-car tests of the experimental train were carried out by Mr. G. J. Churchward, M. Inst. C.E., and at the same time continuous measurements of the electrical output of all three dynamos were recorded. Output in volts and amperes was recorded autographically for one dynamo by an ammeter and voltmeter specially built by the British Thomson-Houston Company for direct-current electric-train measurements, and adapted for train-lighting conditions. Amperes, volts, and time are all recorded autographically, and, during the second of the two runs, distance was also marked autographically on the moving paper from the dynamometer-car 1-4 mile distance-recorder. The moving coil of the ammeter and voltmeter are each excited from a separate battery through a standard ammeter, so that a continuous check on

both readings can be kept by means of instantaneous readings on a standard instrument, and the autographic instruments can be recalibrated during the journey if required. The results are given in Appendix III.

The first run, made on the 16th July, 1909, between Paddington and Bristol, was arranged to represent a fast service. There were five stops and one signal-stop in 117 1-2 miles.

The electrical measurements of amperes and volts for each dynamo are given in Fig. 8, for the beginning and end of this run. The full line is in each case the autographic record, and the other readings were taken at 4-minute intervals by observers. During this run the three dynamos in parallel generated 7.9 kilowatt-hours, and the lamp-input was 5 kilowatt-hours. For 23% of the total time the dynamos were not cut in, during which time the batteries supplied 1.16 kilowatt-hour. The dynamos generated 5.12 kilowatt-hours for lighting (of which 1.28 kilowatt-hour was wasted in regulators and distribution) and 2.77 kilowatt-hours for battery-charging.

From the sum of the three ampere-curves, multiplied by the average instantaneous voltage, a dynamo-output curve in kilowatts was constructed; from this curve the kilowatts input to the three belts from the three axle-pulleys could be calculated from the dynamo-tests. The sum of these three curves plotted to a horse-power scale instead of a kilowatt scale is also reproduced in Fig. 8. On the same time-base, but to a scale one-fortieth of the belt-input scale, has been plotted the locomotive draw-bar horse-power taken from the autographic records of the dynamometer-car. On the fast journey, the average scheduled speed (including stops) being 40 miles per hour, the average draw-bar effort of the locomotive was 277 HP., and the average input to the three belts was 7.8 HP., or 2.8 per cent. of the former.

The second run, made on the 13th of January, 1910, from London to Swindon, was arranged to represent a stopping service, with fourteen stops in 77 1-4 miles.

The electrical output measurements for the beginning and end of the run are given in Fig. 13, Plate 2. During this run the three dynamos in parallel generated 8.07 kilowatt-hours, and the lamp-input was 4.8 kilowatt-hours. The dynamos were not cut in for 31 per cent. of the time, during which the batteries supplied 1.49 kilowatt-hour to the lights. The dynamos supplied 4.46 kilowatt-hours for lighting (of which 1.18 kilowatt-hour was wasted in regulators and distribution) and 3.61 kilowatt-hours for battery-charging.

On the slow journey the average schedule-speed (including stops) was 27 1-2 miles per hour, and the average draw-bar effort was 284 HP., the averaged input to the belts being 8 HP., or 2.8 per cent. of the total, which is the same as the figure obtained before.

In all these results it is to be remembered that the dynamometer-car is included in the draw-bar pull of the locomotive, but excluded from the lighting, since it was lit by gas.

In Appendix III, Table II, this has been allowed for, and an estimate is given in Table III of the annual percentage of locomotive-power to be debited to train-lighting for the experimental train taken over the whole year. The particulars of hours of lighting, days per annum worked by the stock, and the average hours per day worked by a coach, refer only to Great Western main-like stock, and have been carefully analysed by the traffic-department. These figures may be quite different for another railway, and would be very different for suburban or local services.

The average of 1 1-2 per cent. of locomotive draw-bar pull debitable to train-lighting throughout the year may be taken as a very fair approximation for the entire-main-line stock of a railway equipped on the brake-vehicle method, provided it has about the same ratio of generator-coaches to dependent coaches and self-lit coaches as holds in the experimental train. Further, it is obvious that the precentage would only hold for dynamos having about the same efficiency as the Leitner dynamo, and with a belt-slip of not more than 3 per cent., but it would hold approximately for larger dynamos and batteries than those installed on the brake-vans of the experimental train. A careful analysis of the figures on the assumption that all the coaches are self-lit makes the average draw-bar power for train-lighting 2 per cent. of the locomotive-power.

Locomotive-Charges for Extra Weight Hauled.

The question of the additional locomotive-power required to haul the extra weight due to lighting-equipment is open to considerable difference of opinion. Train-resistance is always stated in pounds per ton, but that resistance is composed of several elements. In the Paper read by Mr. Carus-Wilson before The Institution in 1907, the various elements forming train-resistance were separately analysed and valued. For average speeds such as those represented by the two dynamometer-car tests, air-resistance would form at the higher and lower speeds respectively about 30 per cent. and 20 per cent. of the total resistance. The extra weight of internal fittings added for train-lighting will have no effect on the tractive effort due to air-resistance. The percentage due to flange-action in bogie stock depends solely on the weight of the bogies and not on the weight of coach-bodies, which carry all the lighting-equipment with the exception of the axle-pulley. Journal-friction and track-resistance form about 18 per cent. and about 26 per cent. of the total resistance at the respective average speeds during the tests referred to, and the percentage increase in tractive effort on the level, due to additional weight, is directly confined to this portion of the tractive effort. On the other hand, the additional apparatus is mostly placed underneath the coach, and its surface may be the cause of additional air-resistance. The apparatus is very largely shielded by the bogies, and Mr. Wilson, in his Paper, considered the bogies as responsible for the whole of the air-resistance underneath a coach. It seems more likely, however, that the bogies do not shield the dynamo, battery-boxes, and regulator underneath the coach from the action of the air, and it may not be illogical to take the additional weight of these appliances as increasing the resistance in proportion to their weight, although the resistance is really due to their surface. For want of better knowledge it will be assumed that the added weight of the equipment, wiring, and lamp-fittings adds to the train-resistance in proportion to that weight. On going up a grade the extra weight tells, but on all steep rising grades the train will probably be running at a speed at which the dynamo is cut out, so that locomotive-power for generating is saved, and the two are nearly equal in effect.

As in so many details in railway work, a surburban service with stops 1 mile apart or less differs largely from either of the other two services referred to in this Paper. Air-resistance here forms a quite unimportant item, not probably exceeding 9 or 10 per cent.

of the total train-resistance. On the other hand, the power spent in accelerating the train, and the energy wasted in braking, become matters of great importance, since, for a suburban service having a scheduled speed of 16 miles per hour and 1 mile between stops, only about 70 per cent. of the energy at the axles is employed in propulsion, the rest being wasted at the brakes in destroying momentum. In this case the additional weight of the lighting equipment directly increases the tractive effort, and it is clear from the two dynamometer experiments made that rather more locomotive horse-power is required for the stopping service at an average speed of 27 miles per hour than for the quick service with an average speed of 40 miles per hour. Taking suburban services into consideration, as well as fast and stopping services with not less than 4 miles between stops it seems reasonable, for want of fuller information, to assume that the extra weight of the equipment adds to the tractive effort in direct proportion to that weight, although this may be overstating the case by about 50 per cent.

For the experimental train the proportion of the weight of the empty train and locomotive borne by the electrical equipment is:

	Tons
Weight of locomotive and tender	105
Weight of empty six-coach train complete with electrical equipment	160
	265
Weight of electrical equipment, consisting of the generating and controlling equipment on three coaches and the through and coach-wiring, and lighting-fittings in six coaches	4.5

Hence the total weight of the electric lighting equipment is 1.7 per cent. of the total weight of the train with engine and tender.

It is to be remembered that a six-coach train may be, and generally is, below the average size for a main-line working. On the Great Western Railway the average is more nearly eight coaches, while the weight of engine and tender given represents that of the express locomotive which drew the experimental train during the tests, and is above the weight of the average locomotive. The ratio of equipment-weight to train-weight would be higher if the whole stock were lit, since the apparatus for general brake-vehicle equipment would be heavier, and a recent calculation for Great Western rolling stock as a whole makes it as high as 2 3-4 per cent., this percentage including the equipment on idle stock and weight of idle locomotives as well as the stock and locomotives in service.

The annual cost of coal, water, oil, tallow, and small stores and repairs per passenger-engine may be taken as $3,750 per annum. This excludes running-wages and superintendence, items which are not increased by electric lighting of the train. The annual interest at 4 per cent. on the average value of an engine may be taken as $500, and the out-of-pocket expenses for hauling locomotive-coal from collieries to locomotive-depots at $125.

The annual locomotive-expenses per passenger-engine which are directly increased by the lighting, therefore, may be taken as $4,375.

On the average it appears that there are one-and-a-quarter locomotives required per passenger-train, but on the other hand, from Great Western Railway experience, about 25 per cent. of the rolling stock which runs in passenger-trains—consisting of milk-vans, horse-boxes and carriage-trucks—if lit at all would not be lit electrically. These two items balance, and it may be taken that the average annual cost of a passenger-locomotive is $4,375 for each passenger-train.

From the percentages already determined, therefore, an approximate figure can be given for annual locomotive-expenses; both for power to drive the dynamos and for haulage of the weight of the equipment. For the six-coach experimental train it works out thus—

Power to drive dynamos, 1.5 per cent. of $4,375 (Appendix III)	$ 65
Haulage of weight of equipment, 1.7 per cent. of $4,375	75
	$140

Total Costs.

The cost of lighting the experimental six-coach train throughout the year, on the assumption that the train works for 10 hours each day for 237 days, during which time the lighting is on for an average of 4 hours per day, or 950 hours per annum, is then as follows:

Initial cost of equipping train on brake-vehicle method (Appendix I)	$3,805
Annual expenditure—	
Working-costs (Appendix II)	$ 225
Locomotive-costs	140
	$ 365
Capital charges—	
Interest on initial cost at 4 per cent. per annum	$ 150
Reproduction of capital in 20 years by annual sums invested at 4 per cent. compound interest, say 3 per cent. per annum on initial cost	115
Total annual charges per train	$ 630

It will be remembered that the equipment of the experimental train purposely allowed no margin in capacity. If the brake-vehicle method were adopted for the main-line stock of a railway, the dynamos on the brake-vehicles would have to be of 70 amperes output (overload capacity 80 amperes), and the batteries of 210-ampere-hour capacity. This is believed to be sufficient to cope with any combination of coaches, since each brake-vehicle can on emergency look after itself and four other coaches not more than 60 feet in length, or five other coaches not more than 50 feet long. For coaches about 70 feet in length 100-ampere dynamos (overload capacity 120 amperes) are necessary.

Let it be assumed that several thousand coaches have to be lit, and that the number of 100-ampere equipments is small, while 70-ampere equipments are confined to main-line stock only, branch and suburban stock being lit by 50-ampere equipments, and self-lit coaches with 25-ampere equipments. Under these conditions the foregoing initial and working costs, averaged over the total number of coaches, irrespective of whether they are generator-coaches, dependent, or self-lit, is believed to represent very fairly the conditions to-day, and everything is tending to cheapen apparatus.

Safety of Electric Train-Lighting.

The Author has made experiments with various metals forming electric arcs, using an electromotive force of 22 volts. The conclusion come to is that an arc is invariably formed by actual contact at this voltage, but that it does not persist, although enough experiments have not been made to settle the time of persistence. At 22 volts, wood which has been soaked for many hours previously in water passes only a few milliamperes when separating two electrodes which are almost touching. There is no doubt, however, that electric wiring in coaches has charred woodwork after short-circuits. If for the internal

wiring properly insulated cable of good quality is used, and in addition the wiring is protected by carefully-designed fuses, it is believed that complete immunity from fire-risks can be ensured.

APPENDIX I.

EQUIPMENT OF GENERATOR COACH.

Material—	
Two Dynamos, with automatic switches, rated at 45 amperes, complete with suspension-gear, axle-pulley and belts	$ 570
Two Regulators with containing box and coach fixings	270
Two Twelve-Cell Batteries 180 ampere-hours each, with containing box and coach fixings	310
Cable connections between dynamos, batteries, regulators, and switchboards, internal lamp-wiring, through control and other switches for two generator-coaches	105
Lamp-fittings and lamps and sundries for two genera tor-coaches	85
Through wiring and couplers for two generator-coaches	350
Labor—	
Erection of the foregoing material for two generator-coaches, inclusive of factory-charges	290
	$1,980

EQUIPMENT OF DEPENDENT COACH.

Material—	
Internal lamp-wiring, switches, lamp-fittings and lamps for three dependent coaches	$ 165
Through wiring and couplers for three dependent coaches	420
Labor—	
Erection of material for three dependent coaches, inclusive of factory-charges	300
	$ 885

EQUIPMENT OF SELF-LIT COACH.

Material—	
One Dynamo with automatic switch, rated at 45 amperes, complete with suspension-gear, axle-pulley and belts	$ 285
One Regulator with containing box and coach fixings	135
One Twelve-Cell Battery, 180 ampere-hours, with containing box and coach fixings	155
Cable connections between dynamos, batteries, regulators and switchboards, internal lamp wiring, through control and other switches for one self-lit coach	50
Lamp-fittings, lamps and sundries for self-lit coach..	45
Through wiring and couplers for self-lit coach	150
Labor—	
Erection of the foregoing material for one self-lit coach, inclusive of factory-charges	120
	940
	$3,805

The cost is exclusive of a sum of $540 spent for special compartments for containing the experimental apparatus for test measurement; for placing all apparatus except the dynamo above floor-level and for special switches and connections for measurements. It is also exclusive of one extra cell in each battery to make up for voltage-drop in a looped positive of too small section.

This represents the cost of equipping at 1910 prices an experimental train with the first brake-vehicle apparatus and with the first through wiring and couplers. For both items the cost of material and labor has been reduced since March, 1909.

APPENDIX II.

MAINTENANCE.

Maintenance of three thirteen-cell, 180-ampere-hour batteries	$ 75
Note.—This includes extra attention due to 4½ months' service without daylight running, but excludes consequent depot charging.	
Maintenance and renewals of three dynamos inclusive of belts, regulators and switchgear	57
Maintenance and renewals of wiring, lamps and lamp-fittings for six coaches	90
	$222

This maintenance represents that of an experimental train under specially trying conditions of service.

Further experience points to the fact that the battery maintenance would be reduced about 25%, the dynamo-regulator-, and switchgear-maintenance about 20%, and the maintenance and renewal of lamps, wiring, and fittings about 34%, at the present time, when dealing with not less than five hundred coaches, making a total reduction in annual working-costs of about 29% on the above figures.

APPENDIX III.

Percentage of Locomotive-Power Required to Provide Electric Train-Lighting.

The following tables give particulars of the tests with the six-coach experimental train equipped on the brake-vehicle method, to determine the total locomotive draw-bar horse-power and the proportion required by the electric lighting equipment. The train consisted of dynamometer car, lit by gas, and six coaches lit by one hundred and forty-two 10-candle-power tungsten lamps taking 76.5 amperes at 22 volts, or 1,683 watts.

TABLE I.

Particulars of Tests on Electrical Equipment of Six Coaches Only.

Conditions.—All lamps lit and batteries being charged, but lighting of dynamometer car excluded.

	16th July, 1909. London to Bristol 117½ Miles as Fast Train	13th January, 1910. London to Swindon 77¼ Miles as Stopping Train
Number of station-stops	5	14
Average distance between stops, miles	23½	5½
Average schedule-speed (including stops), miles per hour	40.0	27.4
Average running speed (excluding stops), miles per hour	47.8	34.2
Time during which trains were running, mins.	148.25	135.62
Time of journey during which all lamps were lit, mins	177.33	168.88
Time during which dynamos were generating, mins.	136.58	116.03
Ratio of time dynamos were generating to time lights were on, per cent	77.0	69.0
Input to lamps at 22 volts, watt-hours	4,970	4,730
Average output while dynamos in circut, watts	3,473	4,170
Energy generated, watt-hours	7,900	8,068
Ratio of energy input to lamps to output from dynamos, per cent	62.9	58.6

Repeated experiment with watt-hour meter has proved that to keep batteries in proper condition (when the battery capacity is not less than the rated output of the dynamo for 3 hours) the watt-hour input to lamps should be 60 per cent. of the watt-hour output of the dynamos. The experiments, therefore, represent characteristic conditions of working.

The power to haul the train included the hauling of the dynamometer-car, which is lit by gas. Its electric lighting must, therefore, be included, by proportion, in the lighting of the experimental train. The orthodox basis for comparing draw-bar horse-power is the power per ton hauled, and in Table II the lighting of the dynamometer-car has been estimated on the basis of the lamps per ton of train.

TABLE II.

Power Taken by Seven-Coach Train—Inclusive of Dynamometer-Car.

Conditions.—All lights on and batteries being charged.

	16th July, 1909. London to Bristol 117½ Miles as Fast Train....	13th January, 1910. London to Swindon 77¼ Miles as Stopping Train..
Weight of six-coach train empty, tons....	160.1	160.1
Weight of dynamometer-car empty, tons.	27.1	27.1
Total weight hauled by engine, tons......	187.2	187.2
Input to electric lamps in dynamometer-car in proportion to its weight, watts...	285	285
Input to lamps corresponding to maximum lighting of whole train pulled by engine, watts	1,968	1,968
Energy-input to lamps, watts-hours......	5,815	5,538
Ratio of energy-input to lamps to output of dynamo (Table I), per cent.........	62.9	58.6
Generating efficiency: axle-pulley input to belts to output from dynamos, per cent.	55.0	60.0
Energy generated (calculated from foregoing ratio, watt-hours................	9,245	9,450
Average power generated during running-time, watts	3,742	4,181
Average axle-pulley input to belts during running-time, watts	6,800	6,970
Average axle-pulley input to belts during running time, horse-power	9.12	9.34
Average locomotive draw-bar H. P. from curves, Fig. 8, Page 214, Feb. issue and during running-time, horse-power......	277	284
Ratio draw-bar H. P. to drive dynamos to total H. P. under maximum output conditions for seven coaches including dynamometer-car, per cent	3.29	3.29

TABLE III.

Power Taken by Electrical Equipment of Seven-Coach Train Throughout the Year; Under Average Conditions of the Running of the Entire Passenger Stock.

Average time of lighting over G. W. R. system, 4 hours per day.
Average time worked by entire stock, 237 days per annum.
Average time of lighting, 948 hours per annum.
Average time worked by a coach, 10 hours per day.
Average time worked by stock, 2,370 hours per annum.

Annual axle-pulley input to belts while generating kilowatt-hours	6,450	6,605
Annual axle-pulley input to belt while generating, horse-power-hours	8,650	8,850
Pulley input to belts when idle, H.P......	1.15	0.82
Time running idle (2,370—948), hours....	1,422	1,422
Work done running idle, H.P.-hours.. .	1,635	1,166
Total work generating and idle, H.P.-hours	10,285	10,016
Average power throughout year during running time, H.P.....................	4.34	4.23
Average power at draw-bar during running time (Table I), H.P..............	277	284
Ratio of draw-bar H.P. to run electrical equipment (averaged over the whole year) to average drawing H.P. to haul train, per cent	1.57	1.49
Percentage of power required to haul the train debitable to train-lighting, per cent	1.5	

THE DEVELOPMENT OF SELECTIVE TELEPHONE RAILWAY SERVICE.

By John W. Barney.*

From the fact that the increase in mileage of railroads in the United States operated under telephone train dispatching amounted during 1910 to about 60 per cent of the mileage previously so operated, it may be gathered that the subject is a live one. Everything relating to the development and application of the art is eagerly read. On this account the obligation rests upon those who profess to inform upon such topics to set forth a plain account of the facts and the governing principles. Mr. Finley's interesting article in the August issue of the Railway Electrical Engineer seems, doubtless unintentionally, to have left in obscurity some facts easily ascertainable, to have fallen into error regarding the origin of railway selective telephone apparatus and to have overlooked or failed to state some of the principles which do now and ever will, govern selective calling in its ultimate development.

Mr. Finley's statement that it is difficult to tell to which railroad belongs the credit of being the first to establish the telephone in place of the telegraph for putting out regular train orders on the main line of a large railway system may be cleared up easily. The New York Central and Hudson River Railroad established its selector telephone train dispatching circuit between Albany and Fonda, N. Y., in September, 1907, and the writer has yet to learn that its priority in this respect has ever been disputed with success. Furthermore, this circuit was equipped, as stated, with the Gill selector, and the Gill selector has been employed there ever since and is still in service on that circuit. Mr. A. B. Taylor, Superintendent of Telegraph of the New York Central Lines, and Mr. S. L. Van Akin, his assistant, were among the earliest of the railway officials to recognize the value of the selector and the telephone in train dispatching and their

The statement that the conditions governing telephone dispatching were met by "the continued endeavor and the persistent efforts of the telegraph superintendents and the engineers of the various manufacturers of telephone apparatus" is misleading. The Superintendents mentioned above, and some others, lent aid and counsel, but the manufacturers of telephone apparatus had nothing to offer to the railroads when a selective calling system was asked of them and the selector which had proved its worth on telegraph lines was adapted for telephone service, thus making possible telephone train dispatching. Inferentially Mr. Finley's article conveys the impression that the Gill selector was connected only in seies and on that account was found inadequate and was superseded. As a matter of fact the Gill selector of today is essentially that of 1907. A change from 15 ohms to 4,500 ohms. has, however, been made in winding the coils. The principle of bridging the selector was adopted early by the makers of the Gill apparatus and in this, as in other particulars, the changes in the Gill selector have been such as would naturally accompany the development of the art. Certainly the Gill device cannot rightly be classed among either the obsolete or the obsolescent.

It requires only a little study into the selector problem to discover that selective calling systems divide, naturally, into two classes, according to the method of sending out the selective current: by combinations of various impulses, and by a series of consecutive current impulses, i. e. the step-by-step method. As was shown clearly in a paper by Mr. W. E. Harkness, delivered before the Boston convention of the Association of Railway Telegraph Superintendents in June last, the combination system of calling offers the maximum number of selective combinations with the minimum number of current impulses, and, other things being equal, is the more economical from the standpoint of current consumption. The step-by-step system is limited in the total number of selections, owing to the large number of current impulses required to meet service conditions.

In a comparison of current requirements the step-by-step mechanism shows at a disadvantage at stations above twenty in number, a limitation which indicates difficulty in meeting the demand for a larger number of stations or extensions of existing circuits. The number of current impulses required, without clearing-out impulses, as shown in Mr. Harkness's paper is: For 48 stations—Combination selector, 4-figure call, 13: 3-figure call, 12; 2-figure call, 12. Step-by-step selector, 48. For 180 stations Combination selector, 4-figure call, 19; 3-figure call, 18; 2-figure call, 18. Step-by-step selector, 180. These are the basic facts which should be kept in mind in considering selective calling for railway service.

*This article was prepared for publication in our September issue, but has been unavoidably deferred.

DATA ON CAR LIGHTING.

The Special Committee on Relations of Railway Operation to Legislation issued a request under date of November 24th, 1911 for a statement from each of the various railroads showing the manner in which passenger car equipment was lighted as of November 1st, 1911.

Replies from two hundred operating companies have been received to date representing 227,089 miles of track and operating 54,961 passenger cars.

In the accompanying table No. 1 is given an analysis of all classes of cars, and in Table No. 2 is given the comparative totals for the various methods of car lighting in use. This latter table shows that of all the passenger cars operated there are but 16.6 per cent which have an auxiliary system of lighting, the balance, 83.4 per cent being equipped with but one system. This also shows that a total of 25.6 per cent of all passenger cars are equipped with electric lighting; practically one-half of which are operated without any auxiliary light whatsoever.

These figures are of importance and are of considerable interest in showing the relative use of the various types of car lighting equipment. They are evidently somewhat more complete than the data compiled by our committee on Data and Information last fall, as the total number of cars reported at that time were 45,251 of which 11,017 or 24.4 per cent were lighted by electricity. The present data shows a total of 54,961 cars of which 14,087 or 25.6 per cent are electrically lighted.

TABLE NO. 1.

In Service November 1, 1911.

PASSENGER EQUIPMENT—METHOD OF LIGHTING.

	Oil Only	Gas Only	Electricity Only	Acetylene Only	Carbretor System	Oil & Electricity	Gas & Electricity	Acetylene & Electricity	Oil & Gas	No. Lights	Total
	A	B	C	D	E	F	G	H	I	J	K
1. Postal	132	594	377	9	1	121	136	20	304	..	1694
2. Camb't'n Mail & Baggage	1744	798	88	75	73	222	16	21	316	..	3353
3. Baggage & Express	2830	2729	283	96	360	330	82	19	557	64	7350
4. Comb. Pas'r & Baggage, Pas., Mail & Baggage, Pas'r & Mail	2272	1521	342	192	127	56	32	34	103	..	4679
5. Coaches	8619	12159	2010	707	574	1167	701	359	530	3	26829
6. Parlor, Sl'p'g & Din'g	256	2195	3183	24	...	283	2642	505	44	2	9134
7. Business & Instruction	225	170	79	29	14	59	255	15	48	..	894
8. Motor	242	22	531	96	1	109	...	10	...	..	1011
9. Miscellaneous	17	...	...	...	...	...	...	...	...	..	17
10. Total	16337	20188	6893	1228	1150	2347	3864	983	1902	69	54961

TABLE NO. 2.

	Exclusive No.	Exclusive Per Cent	More Than One Method No.	More Than One Method Per Cent	Total No.	Total Per Cent
Oil	16,337	29.7	4249	7.8	20,586	37.5
Gas	20,188	36.7	5766	10.5	25,954	47.2
Electricity	6,893	12.6	7194	13.0	14,087	25.6
Acetylene	1,228	2.2	983	1.9	2,211	4.1
Carburetor	1,150	2.1	....	...	1,150	2.1
None	69	0.1	....	...	69	0.1
Total	45,865	...	9096*	...	54,961*	...
Per Cent		83.4	....	16.6*		100.0*

*Duplications eliminated.

"Street Railway Lamps," is the title of Bulletin 18 recently issued by the Engineering Department of the National Electric Lamp Association. This bulletin gives complete data on Gem and Carbon lamps for street railway use, and should be of considerable interest to those connected in any way with train lighting work. Copies of this bulletin may be had on request.

ELECTRIC VEHICLE TESTS.

The Department of Electrical Engineering of the Massachusetts Institute of Technology has under way an important investigation on the adaptability of electric vehicles for trucking purposes, more especially with reference to the conditions in Boston and its vicinity. Mr. H. F. Thomson, the research associate in carrying on this work, is making substantial progress in the inquiry. The inquiry is directed along several particular lines, including cost of the service, convenience of the service, difficulties and expenses due to the delays in loading and unloading at freight houses and the like, delays caused by drivers, and corresponding matters. The railroads entering Boston are co-operating with the part of the investigation relating to time occupied in loading and unloading trucks at the freight houses, including the time occupied in getting to the loading platform. The freight house conditions are being investigated by students of the Department under the direction of Mr. Thomson.

An appropriation for this work was made to the Institution by the Edison Electric Illuminating Company of Boston. The research was begun about the middle of the year 1911 and is expected to extend beyond the year. It is expected to result in a report or series of reports on the relative merits of electric vehicles, other mechanical vehicles and horse vehicles for city and suburban delivery, for trucking and for the other purposes for which vehicles are used in the city and its suburbs.

SCIENTIFIC ILLUMINATION.

A booklet just issued by the Macbeth-Evans Glass Company entitled "Scientific Illumination" takes up the problem of efficient lighting from a very practical point of view. The book is intended for both the layman and the engineer and is written in a clear and concise style, but at the same time presents considerable technical data so that it becomes of interest to both. It is well illustrated and bound in board covers.

We believe that the Macbeth-Evans Company will be pleased to furnish a copy of this gratis to any if our readers.

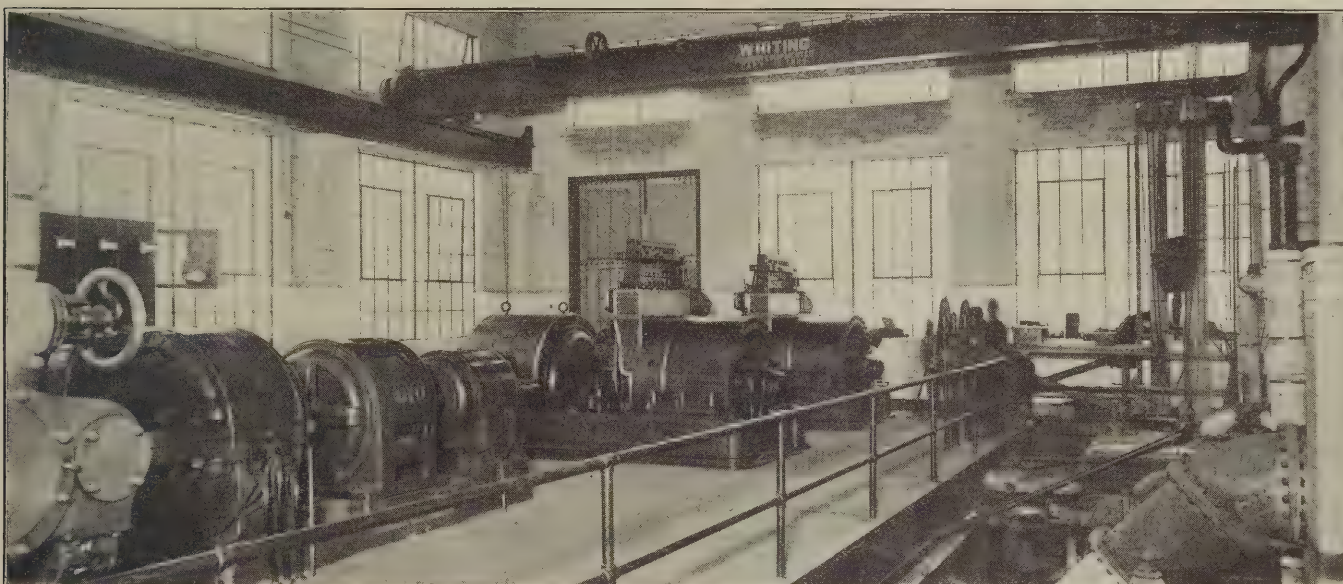
NEW EQUIPMENT ORDERED.

The Philadelphia Rapid Transit Company and the International Railways Company of Buffalo, N. Y., have awarded a contract to the Westinghouse Electric & Manufacturing Company for 500 complete car equipments. Each equipment consist of two No. 306-C box frame, interpole railway motors, rated at 50 h. p., 500 volts, type K-36 controllers and Westinghouse car type circuit-breakers.

SHOP SECTION
EDITED BY
GEO. W. CRAVENS

THE NEW ROCK ISLAND POWER PLANT AT CHICAGO.

The repair shops at the Chicago terminus of the Chicago, Rock Island and Pacific Railroad are located in the southern part of the city, along the main line of the road, and comprise a round house, wheel shop, machine shop, boiler shop, passenger car repair shop, blacksmith shop, electric and steam power plant and several smaller buildings. Quite extensive yards are provided here also for coaches.



Interior View from North End of Room.

To provide power for these shops, and to supply steam for the coaches standing in the yards in cold weather, the new power plant has been erected and has recently been placed in operation. This plant was designed and installed by the Arnold Co., Chicago, and is located in a brick building approximately 96 ft. 10 inches by 88 ft. 3 inches in size and stands near the center of the shops and about the center of gravity of the load, both steam and electric. The soil here contains a sub-strata of quick-sand, so it was necessary to float the building on foundations of special construction. The stack, which is 225 ft. high and 9 ft. inside diameter, rests on 198 piles driven to the shale rock foundation and capped with concrete. The steam turbines are operated non-condensing in order that the exhaust steam may be used for heating the coaches in the yards.

A good idea of the general arrangement of the interior of the power house may be obtained from the illustrations herewith. The impression is of plenty of space for the convenient operation of the plant, and yet there is no apparent waste of space. All of the principal apparatus is in one room and on one level, the auxiliaries being in the basement but visible through the opening in the main floor. This pit for the pumps, etc. lies along the wall which separates the engine room from the boiler room and is protected by an iron railing. A 15 ton Whiting crane of 38 ft. 6 inches span serves the engine room. It is hand operated.

In the south end of the engine room are the 2 G. E. horizontal turbo-generators. These run non-condensing on 150 lbs. of steam at 3600 r. p. m. and are rated at 500 k. w. each, 480 volts, 3-phase a. c. at 80 per cent power factor. Next to these sets is a motor generator set consisting of a 190 h. p. 480 volt synchronous motor running at 900 r. p. m. and direct connected to 2 d. c. generators. One of these is a 100 k. w. 220 volt generator for power and the other is a 25 k. w. 125 volt exciter for the turbo-generators. The alternating current is generated at a frequency of 60 cycles.

There is also an engine driven 100 k. w. 250 volt d. c. generator here running at 275 r. p. m. It is direct connected to an Ideal engine and is used as an exciter when starting up the plant. A balancer coil for the 100 k. w. motor driven generator and 2 balancer coils for the engine driven 100 k. w. generators are located in the basement just beneath the respective machines.

In the north end of the engine room are located the 2 horizontal cross compound air compressors which supply air for all purposes about the shops. One of these is a Chicago Pneumatic Tool Co.'s. size 24 CSC two stage compressor supply 600 cu. ft. per minute, and the other is an Ingersoll-Sargent two stage compressor supplying 1000 cu. ft. per min. The steam piping for all of the prime movers in this plant is carried beneath the floor and brought up through in such a manner as to expose the smallest amount of it to view.

Boiler Room and Auxiliaries.

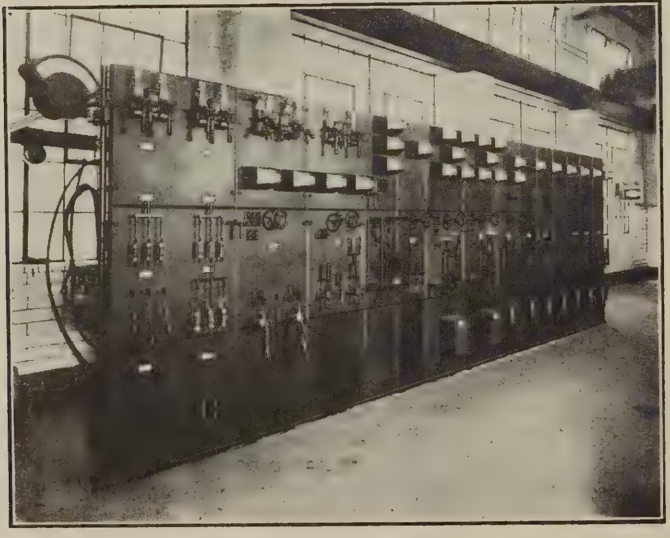
The boiler room is located in the west half of the building with its floor below grade about 8 feet, and contains 5 Geary horizontal water tube boilers of 410 boiler h. p. each arranged in pairs and equipped with "Green" stokers. Space is provided for a sixth boiler at the south end of the room. Back of the boilers is a

space about 6 feet wide in which the main piping is located, and from which the branches run to the engines, etc.

Overhead above the space in front of the boilers is a long reinforced concrete coal bunker of parabolic section with leaders running down to the stoker-hoppers. This has a capacity of 100 tons and is loaded by a conveyor running from a side track outside the building. An auxiliary coal-storage pit is placed underground along the outer side of the west wall of the building. A track runs over this pit for convenient unloading, and its capacity is 300 tons.

Coal is carried up to a travelling coal crusher on the roof and from this it drops through a slot in the roof to the bunker. The track for the crusher runs along the edges of the slot, which is open to the weather. Ashes from the furnaces drop into pits below and then down into small cars running beneath the floor. When full, these cars are run out through the end of the building onto air hoists and raised for dumping into empty cars.

In the basement under the engine room are the auxiliaries, consisting of:—2 American 16 in. x 10 in. x 16 in. steam pumps with a capacity of 160 gals. per minute each; 1 Blake-Knowles 2000 h. p. feed water heater; 2 vacuum pumps for the shop heating system, Marsh 8 in. x 12 in. x 12 in., giving a vacuum of approximately 10 in.; and space for three other pumps to be added later for washout, circulating and drinking water. The exhaust pipe from the steam engines above runs along the floor of this basement to the feed water heater and to the shop and yard heating system, and is a spirally riveted pipe. There are 2 oil separators in this pipe.



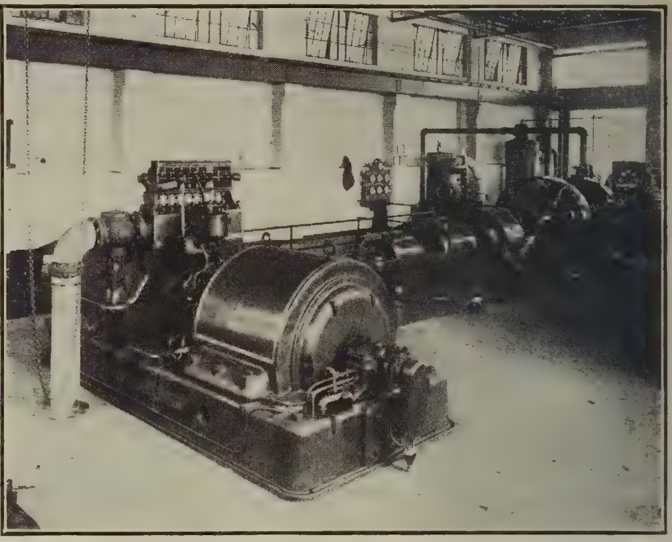
Main Switchboard.

Switchboard.

The main switchboard stands along the east side of the engine room facing the apparatus and consists of 14 black marine finished slate panels. These panels are 90 in. in height, in three sections and mounted on pipe framework, all instruments are of the horizontal edgewise type and the board was built by the General Electric Co.

Beginning at the left end the panels are as follows: D. C. voltmeter, 300 volt scale, on swinging bracket; 8 circuit d. c. feeder panel; engine driven d. c. generator panel; motor driven d. c. generator panel; TA. voltage regulator panel; 125 volt exciter panel; No. 1 a. c. generator panel; No. 2 a. c. generator panel; synchronous motor panel, and six a. c. feeder panels. On the right end of the board is a swinging bracket containing a synchroscope and a. c voltmeter. The a. c. panels each contain a hand operated remote control oil switch and the d. c. panels contain carbon break circuit breakers.

Mounted on pipe framework back of the switchboard are the oil switches for all of the a. c. machines. These are hand operated from the front of the board by means



Interior View from South End of Room.

of mechanism running beneath the floor. Mounted on the framework, over the oil switches, are the current transformers and the a. c. bus bars, the d. c. busses being on brackets on the back of the board. All wiring is carried through the floor in iron conduits and along the ceiling of the basement by insulated hangers. The distribution system is through underground conduits from the building.

The generator rheostats are located in the basement, suspended overhead. Two Pittsburg 60 kw., 60 cycle, 440-220-110 volt transformers operating on open delta are located in the basement for the shop lighting system, and the balancer coils for the d. c. generators are hung on the walls, as stated.

The engine room is lighted with 10 individual 250 watt tungsten lamps suspended about 20 ft. above the floor and spaced about 16 ft. apart in a staggered relation. Each of them is fitted with a deep steel shade extending full length of the lamp and the illumination of the room approaches daylight very closely in effect. The main lighting in the boiler room is from 3 of the same kind of lamps, with several small carbon lamps above the boilers. A single 250 watt tungsten lamp is suspended outside the boiler room for light when unloading coal.

The thanks of the writer are hereby extended to the Messrs. F. E. Hutchinson, E. Wanamaker and F. Glover for their kindness in supplying some of the data used herein.

LAMP RESEARCH BULLETINS.

The National Electric Lamp Ass'n has just issued the first of a series of bulletins on engineering research in incandescent lamps entitled, "Lamp Efficiency." These bulletins will be devoted to a scientific discussion of various problems that bear upon the manufacture and use of incandescent lamps. A post card request will bring you the whole series as they are published.

Last month we studied, "Magnetism," and just touched on its relation to the flow of an electric current in a wire. This month we will take up, "Generators."

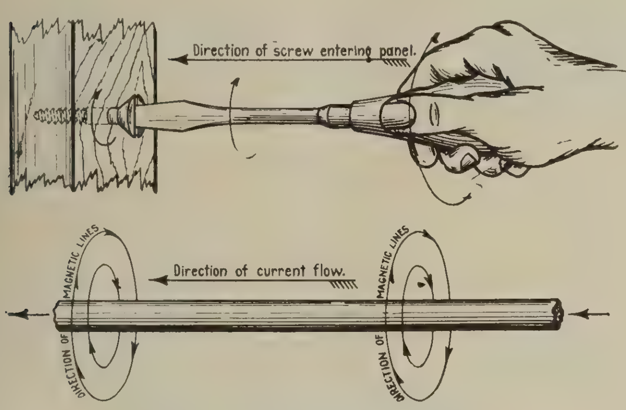


Fig. 7. Rule of the Screw Driver.

Principles of the Generator.

This big subject which is the very foundation of the multitude of electrical conveniences of the present day depends entirely upon the peculiar relation between electricity and magnetism, so it becomes of utmost importance that we get this relation clearly in mind. Electricity is one thing, magnetism, another; they can each exist without the other; magnetism, in a permanent magnet and electricity in a Leyden jar or, "Condenser," or in the atmosphere just before a thunder-storm. Apparently, however, wherever relative motion of either occurs, the one generates the other: when an electric current flows through a conductor it creates a magnetic field about that conductor, and conversely, when a conductor is moved through a magnetic field an electric current is induced in that conductor.

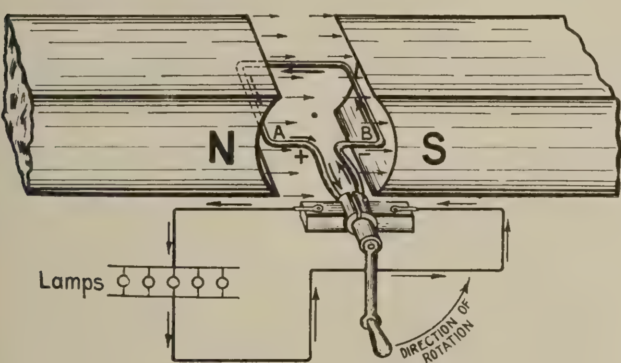


Fig. 8. Elementary Generator.

There is a definite relation in direction of current flow and magnetism which is most easily remembered by the simple, "Rule of the Screw-driver," showing Fig. 7; that is, the current flows in the direction the screw moves and the lines of magnetism go in the direction you turn the screw-driver.

When a wire is forced through a magnetic field as shown in the moving picture series of Fig. 11, it gathers lines of force about it in the direction as shown, and, remembering our screw driver rule that a screw turned in the direction shown would come out, the current in this wire, Fig. 11, will flow toward the reader. If it were pushed upward again the magnetic lines would be gathered in the reverse direction and the current would flow away from you.

Now if we form a piece of wire into a loop and rotate it into a magnetic field as shown in Figs. 8, 9 and 10 we have the first principles of the direct current generator. When revolving the coil in the direction shown and it comes to the horizontal position of Fig. 9 current will be generated in the coil as shown and will pass out through the commutator segments to the lamp circuit. The voltage developed in the coil will depend upon the speed of rotation and the strength of magnetic field, while the current flowing will depend entirely upon the resistence of the external circuit, i. e. the number of lamps turned on.

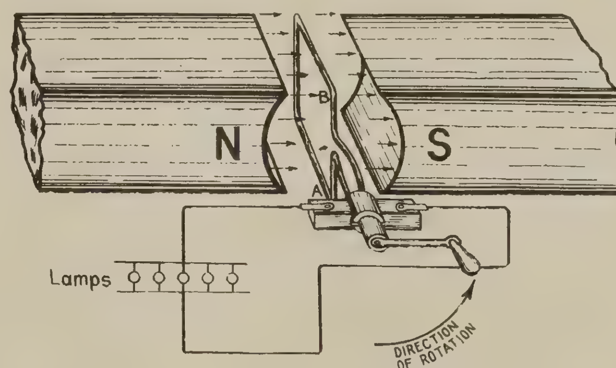


Fig. 9. Elementary Generator.

When the coil reaches the position in Fig. 9, however, it is no longer cutting through the magnetic lines but moves parallel to them, hence no voltage is developed and no current flow at that instant. When the conductor B starts downward across the magnetic lines of the N pole to the position of Fig. 10, it gathers magnetic lines about it in the reverse direction, hence the current will reverse in the coil of wire every half revolution.

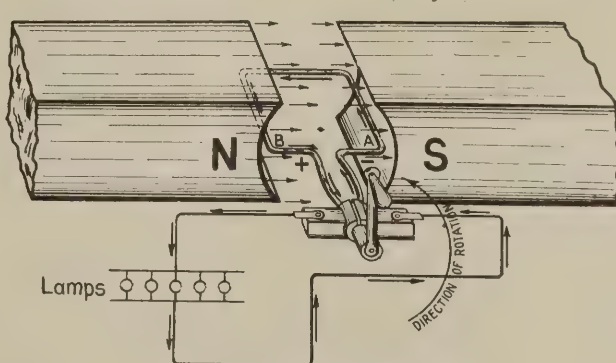


Fig. 10. Elementary Generator.

But please note that although the B end of the coil has changed from + to — its commutator segment has now reolved so as to make contact with the — brush instead of the + brush; hence the direction of flow through the lamps will then be maintained constant although the voltage developed falls to zero every time the coil comes to a vertical position. The voltage developed

by rotating a single coil in a magnetic field would be very low, and is not a practical generator, but the above illustration serves very well in explaining the principles of the generator.

Now then if instead of a single turn of wire, we place numerous coils of a great many turns each in the slots of an iron armature core and connect the ends of each coil to commutator bars, we have the modern armature as shown in Fig. 12.

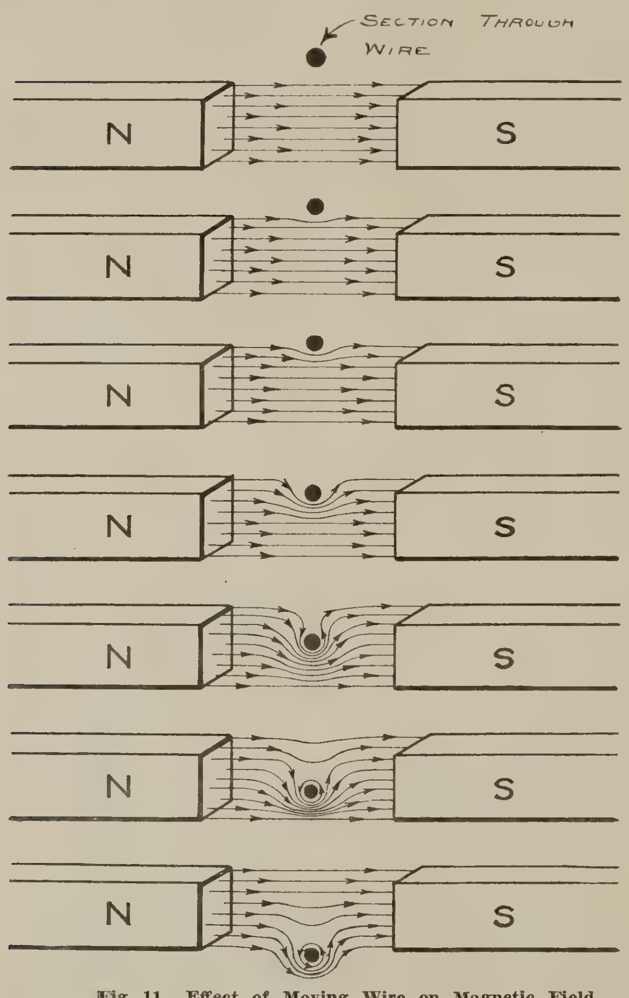


Fig. 11. Effect of Moving Wire on Magnetic Field.

Again referring to Fig. 11, where the wire was passes through a magnetic field (assuming the ends of the wire connected so a current can flow through it) it will require a certain force to push that wire through the magnetic field very similar to a knife cutting through cheese. Now then, if we revolve a great number of wires in a magnetic field as in the modern generator it requires a correspondingly greater force, and the energy exerted in this force is just equal the energy consumed in the lamps, or whatever is in the generator circuit plus a slight amount for friction and armature loss in the generator itself. If the armature is run light, that is on open circuit it would take but a very small force to operate it as no current flows, in fact, just enough to overcome friction and armature losses. As the load is thrown on the generator, however, it requires that the driving force be always just equal to the energy consumed in the lamps plus the generator losses. A horse power is equal the 746 watts so if the lamp circuit is consuming 1,492 watts, the equivelant of 27-16 c. p. carbon lamps, or 100-15 watt tungsten lamps, it will require a little over 2 horse power to drive the generator.

The Generator Field.

In speaking of the generator field we have so far, for purposes of simplicity, considered it as created by a permanent magnet, but in all generators, except magnetos this magnetic field is created by a field winding on each pole piece consisting of a great many turns of wire through which an electric current passes. As explained last month in connection with Fig. 5, the magnetic lines about each wire in the coil unite to form a powerful magnetic field identical with that of a permanent magnet.

The Commutator.

The commutator, instead of being simple two-pole affair as in Fig. 9, is made up of a great many segments or copper bars to which the ends of the coils of wire in the armature are soldered. These coils as they pass across the face of the magnet pole each generate a certain electro-motive-force and as the positive end of one coil is soldered to the same commutator bar as the negative end of the next one, the coils are all in series and the

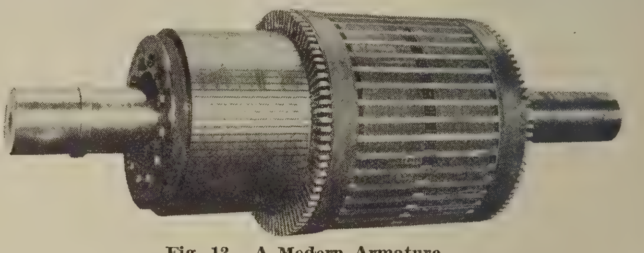


Fig. 12. A Modern Armature.

voltage of the whole set is the sum of the individual voltages in each of the coils just as it is in case of a storage battery composed of a number of cells. When an armature coil reaches a point midway between the pole faces, as in Fig. 9, no electro-motive-force will be generated in that coil and it is at this point that the commutator bars to which its ends are connected should come under one of the brushes. This is called the "Neutral point." It is quite obvious that if the brush touched the commutator bars of a coil while that coil was still generating an electro-motive-force it would short circuit the coil and a heavy current would flow in that particular coil just as when one cell of a battery is short circuited. It is therefore evident that these commutator bars which really represent the connectors between the various cells in a storage battery should be carefully insulated from each other. This is usually done with sheets of mica placed between the segments.

In certain cases where the brushes are not properly set or where the magnetic field becomes distorted a serious commutator sparking occurs due to local short circuit in the coil being commutated. This, however, is not the only cause of brush sparking as it may often be due to the fact that the mica sheets between the commutator bars have worked up and prevent good contact of the brush on the copper segments. These should be filed down with the edge of a three cornered file, but care should be taken not to cut too deep as this will leave a groove that will collect dirt and copper dust causing a band of tiny sparks over the entire face of the commutator.

As to the distorting of the generator field, it should be noted that the current in the armature flows in two paths from the negative brush through the armature to the positive, just like two storage batteries in parallel: in passing through to the various armature coils it loops around the iron core of the armature a great many times and as in any other coil of wire it creates a magnetic field of its own which is normally perpendicular to the main field of the generator. This armature magnetism com-

bines with the main field magnetism and distorts it as shown in Fig. 13, having the same effect as shifting the armature brushes out of place. The coils will no longer be commutated in the neutral position but will be still

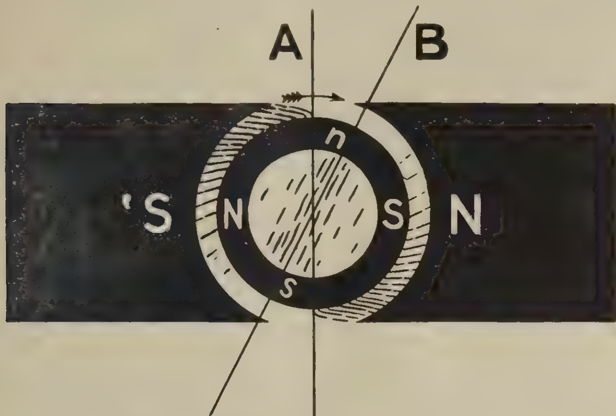


Fig. 13. Distortion of Magnetic Field.

generating a volt or two when they come under the commutator brush. This will cause a direct short circuit of the coil and heavy sparking will occur. This is destructive to both commutator and brush and should be carefully avoided.

To prevent this shifting of generator field as the load comes on, an "Interpole," or small field placed midway between the main generator fields is supplied in modern generators. The winding on this small field is placed in series with the armature and consists of a few turns of heavy wire, one half the total number of turns in the

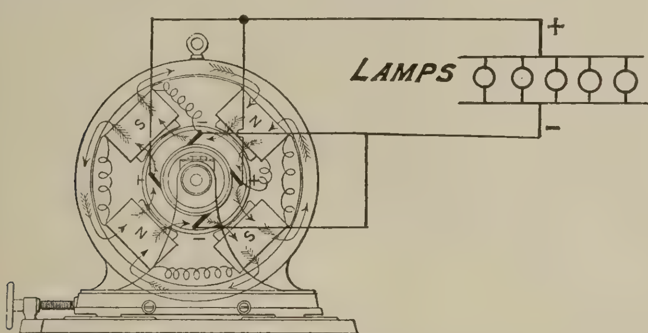


Fig. 14. Magnetic Circuits of Four Pole Generator.

armature, so that as the load comes on a magnetic field will be generated in this interpole which will be just equal to the armarture magnetism and as it is opposite in direction it willl neutralize this armature magnetism which causes brush sparking and entirely eliminate trouble from this source.

Compound Fields.

When a current flows through a wire a voltage drop will occur just as there is a drop in pressure or any water or air pipe line; the nearer you get to the pump the better the pressure. Every wire has resistance and it causes a certain voltage drop when a certain current is forced through it. If this current is doubled it doubles the voltage drop, if it is reduced to half the number of amperes, the voltage drop is reduced half, etc.

In order to maintain the voltage at the lamps some distance away from the generator constant regardless of the load it is necessary to increase the generator voltage to make allowance for the increasing voltage drop in train lines or other wires as the load comes on. This on some trains may amount to as much as fifteen volts. In order to compensate for this drop and deliver constant voltage at the lamps, the generator voltage must be automatically raised 15 volts as full load is thrown on, 7½ volts at half load etc. This is accomplished by placing a few turns of heavy wire on the generator field windings and the entire generator current passed through these coils. Then as the load is thrown on the generator the heavy current flowing through the series field winding will increase the magnetism of the generator field and cause the generator voltage to be raised from 65 volts normal to 80 volts which is required to overcome the line drop and deliver 64 volts at the lamps.

The iron core of a generator is made up of a great number of thin circular discs of sheet iron. These are coated with a thin varnish which insulates them from each other. Years ago generators were built with a solid iron core, but it was found that the armature heated up even when it was run light. This was largely caused by the fact that the cast iron armature core acted like a great single coil as in Fig. 8, but was short-circuited on itself, so that in revolving in the magnetic field it generated a fraction of a volt, which, on account of the extremely low resistance of the iron core caused a heavy current to circulate around through the armature. These currents circulating in a metal which is revolved in a magnetic field are called "Eddy Currents."

Motors.

Any direct current generator can be operated as a motor by placing it in circuit of proper voltage, in fact, if storage batteries are in circuit on a head end system and the turbine shut down without opening the generator switch, the current from the storage batteries will flow back through the generator and run it as a motor. This will cause great waste of battery current. To prevent such trouble head-end systems should be equipped with an under-load as well as an over-load circuit-breaker. Then when the turbine is shut down and the generator current falls to zero, the under-load circuit-breaker will open the generator circuit before the battery can discharge through the generator and run it as a motor.

QUESTIONS AND ANSWERS.

1. *Ques.* A coil has 1,000 turns of wire and 1.5 amperes flowing in the coil. How many ampere turns of magnetisation generated? *Ans,* 1,500 ampere turns.

2. *Ques.* How many amperes must be passed through a series coil having but 10 turns of heavy wire to give the same magnetising force as above? *Ans,* 150 amperes.

3. *Ques.* Why are the windings of a series field of a generator composed of a few turns of large wire? *Ans.* Because usually the entire generator load passes through this coil and the wire must be big enough to carry that heavy current.

4. *Ques.* What is the purpose of the series winding of a generator? *Ans,* To boost the generator voltage so as to compensate the voltage drop in train wires as the load is thrown on.

5. *Ques.* Why is the shunt field winding composed of a large number of turns of fine wire? *Ans,* We want to use as low a field current as possible and by using a large number of turns with low field current we get the same effect as, say, twice the amount of current and half the number of turns.

6. *Ques.* What insulating materials are used on dynamos? *Ans.* Varnished cotton and paper for coils and mica between commutator segments.

7. *Ques.* Why must dynamos be kept dry? *Ans.* Because if they get wet the cotton and paper insulation becomes damp and the armature coils then become grounded on the iron core of the armature causing short circuits.

8. *Ques.* What are the neutral points of the dynamo? *Ans.* It is the point at which brushes may be placed without causing commutator sparking.

9. *Ques.* Why is it important to have the brushes in proper position at the neutral points? *Ans.* Because if they are not they will short-circuit some of the armature coils and cause severe sparking just as if you short-circuited one cell of a storage battery.

10. *Ques.* What is another cause of brush sparking? *Ans.* Mica insulation between commutator segments works us so as to cause poor contact of the brush on the commuta-

tor. File it down with the edge of a three-cornered file, but be careful not to file too deep.

11. *Ques.* What causes sparking between commutator bars not under the brushes. *Ans.* A dirty commutator, or perhaps you filed the mica too deep and copper dust has collected in the grooves, causing short-circuits.

12. *Ques.* If the generator fails to pick up or builds up in the wrong direction. What should be done to make it operate correctly? *Ans.* If you have battery current available connect the positive field to positive battery and negative field to negative battery, then pass a strong current through the generator field winding in the right direction. Care must be taken to disconnect at least one of the armature terminals in doing this, otherwise you will short-circuit the battery through a dead generator. Then connect back as at first, cutting the battery off the field circuit and start up the generator, if the machine still builds up in the wrong direction reverse the generator fields and start up your machine.

13. *Ques.* Since a two-part commutator is so simple in construction why are armature windings subdivided into many coils, thus necessitating many commutator bars? *Ans.* If all the armature conductors were in one large coil and there were only two commutator bars, each a half circle, the voltage would fall to zero twice every revolution as explained in connection with Fig. 9.

14. *Ques.* What is meant by a laminated core and why is it necessary? *Ans.* The armature is made up of a great many thin discs of varnished sheet iron. This is to prevent the flow of "Eddy currents" from one end of the armature to the other through the iron core which would cause excessive heating.

15. *Ques.* How many watts make a horse power? *Ans.* 746, the equivalent of 13-16 c. p. carbon lamps, or 30-25 watt lamps.

16. *Ques.* If the voltage drop in a train line in 5 volts with 40 amperes flowing, what will it be with 80 amperes? *Ans.* 10 volts.

17. *Ques.* Why must there be both under-load and over-load circuit-breakers on head end systems having storage batteries in circuit? *Ans.* The over-load breaker is to open the circuit in case the load becomes more than the generator can handle, but the under-load breaker is to open the circuit in case steam is shut off without opening the generator switch. If there were no under-load breaker the batteries would discharge through the dead generator and run it as a motor, causing a great waste of battery current.

PRACTICAL STUNTS.

We pay for ideas published in this section. Send us some of your stunts—never mind about the fine English and drawings, just put it in your own words and send us a pencil sketch if necessary to explain your idea.

The other night I was on a train with 110 volt head end system and a private car was picked up along the line with officials of the road. This had a 64 volt axle equipment and was wired so that it could be connected to the train line and operated from the head end. The axle dynamo was out of commission on account of having lost its belt and there was no extra belt on the car to put on so we were up against a problem:—a 60 volt axle equipment out of commission on a private car of officials of the road and the balance of train lighted from a 110 volt head end system. There were no extra 110 volt lamps in the dynamo baggage car to equip this private car with so as to light it from head end and no belt available for the axle dynamo until the next day, the batteries moreover were run down so low that it was impossible to read in the car.

The dynamo baggage man was asked if there was no way he could furnish light for this private car and was at a loss to know what to do. He said if he had the right type lamps he could light the car, or if he had an extra belt he could apply it and put the axle dynamo in service, but as there were no extra lamps on, and no extra belt—he said there was nothing he could do. I then suggested that he light the 64 volt lamps from the 110 volt head end system but he said he would burn up every lamp in the private car if he did. I then went into this affair myself and I made up my mind to furnish light on that car if there was any way of doing so.

I started first to run the voltage down to about 66 volts on the dynamo in the baggage car—this, of course, giving a very poor light on the 104 volt lamps of the train. Then when I had the voltage set at 66 volts on the dynamo in the baggage car I went into the private car and pulled out the battery switch and threw in the train line switch. All the lines in the private car then burned from head end 66 volt system and the private car was nicely lighted, but the balance of the train was not. Then I went forward to the dynamo car and boosted the voltage up to 80 volts but this had very little effect on the 64 volt lamps in the private car. Everything seemed to go along very nicely—only I wanted better lights on the 104 volt lamps, so boosted the voltage on the dynamo up to 100 volts. I was looking for the lamps to burn out in the private car at this voltage, but they were just about the same as when I had the dynamo at 80 volts.

The porter on the private car told me that they were all well pleased with the lights and remarked it was the best light they had had for some time. I was as well pleased as they were. When I had the car lighted and working O. K. on 100 volts I then boosted my voltage to 110 volts on the dynamo; in doing so I brought the 104 volt lamps up to full candle power but took another chance on burning out the lamps in the private car. On going back to that car again, however, I found everything doing nicely.

I must say I found out afterwards why the 64 volt lamps did not burn out in the private car on the 110 volt head end circuit. At the next stop I walked alongside this car to see how the train looked and how the lights showed up and incidentally discovered the key to the whole proposition. You should have heard that lamp regulator hum! It was going to beat the band and I thought it might burn out, so kept a close watch on it.

You see, the whole show was in the lamp regulator—that did the business that night. I don't know if this is of any interest to anybody but I thought it might be a good thing to let the boys know about it. Its alright to take a chance once in awhile.

H. J. F.

A NEW LINE OF MOTOR STARTING RHEOSTATS.

The Electric Controller & Mfg. Co., Cleveland, Ohio, has recently placed on the market, a new line of starting rheostats for series, shunt, or compound wound, direct current motors. The manufacturers claim the following important advantages for these rheostats:

The resistance wire, the capacity of which is liberally proportioned, is wound on asbestos-covered, metallic tubes through which a draft of air flows. While this draft of air efficiently conveys the heat away from the resistance, yet it does not at any time touch the hot resistance wire, the obvious result being unusual freedom from oxidization of the resistance wire.

The highest grade of monson slate is used, having beveled edges and oil finish.

On all sizes of the contacts are removable from the front of the rheostat, without disassembling or interfering in any way with the wiring or resistance.

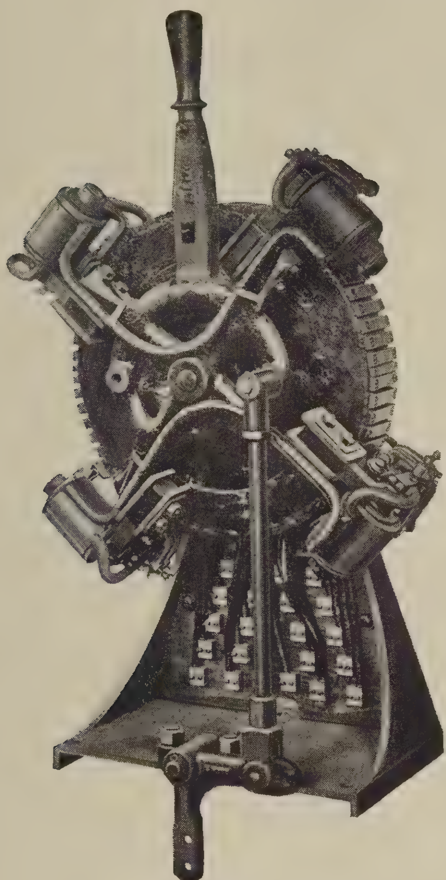
The retaining magnet is iron-clad, thus being protected from mechanical injury.

The E. C. & M. Motor starting rheostats are regularly furnished in sizes from ¼ HP to 35 HP, 110 volts, and from ¼ HP to 50 HP, 220 and 550 volts.

A NEW CRANE CONTROLLER.

The well known "grindstone" type of controller used extensively in connection with direct-current motors operating cranes, hoists, steel-mill machinery, etc., has proven eminently satisfactory. It has recently undergone a refinement, however, which will still further increase its value by simplifying its construction and increasing its durability.

As shown in the illustration, the controller consists essentially of a cast iron frame on which is mounted



Grindstone Type of Controller.

a stationary disc carrying the contact pieces and cross connections. Pivoted the resistors can either be mounted on the frame or separate.

As a result of a series of experiments, the Westinghouse Electric and Manufacturing Company has recently placed on the market controllers of this type in which the disc is made of concrete instead of stone. By a special treatment, the concrete disc is made a thorough non-conductor and at the same time moisture resisting. The use of concrete permits the cross connections between the segments to be made within the body of the disc, thereby giving the disc a "re-inforced" concrete construction and at the same time producing a more compact piece of apparatus. The concrete disc with its self-contained cross connections also gives the controller a neater appearance than the older type.

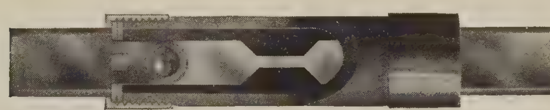
Figs. 1 and 2 are front and rear views respectively of the new concrete "grindstone" controller. In this particular piece of apparatus the resistors are separate and not shown. The contact pieces are attached to the disc by screws in the same way as in the older type are as easily renewable. A blow-out coil of asbestos insulated wire is mounted on each brush-holder to disrupt the arc formed in opening circuits.

A NEW TYPE OF CARTRIDGE FUSE.

Since the advent of the cartridge enclosed fuse and its general adoption a number of years ago, there have been a number of attempts to construct a product of this nature which would possess the necessary electrical characteristics and at the same time be renewable at a very low cost, as the continual replacement of a complete cartridge, especially in places where fuses are blown frequently, increases maintainance expense of the equipment very materially.

Most of the attempts along this line so far have been made without an understanding of the physical requirements of the elements involved and in prac-

tically every case with the use of commercial tested fuse wire for the fusible element. In nearly every instance the performance of a cartridge fuse of this description was decidedly unsatisfactory, as the fibre shells would in many cases run up on continued overloads and in cases of a very heavy short circuit on higher capacity, fuses would violently explode, rupturing the shell beyond repair.



The Economy Fuse & Mfg. Co., of Pittsburgh, Pa., have recently placed on the market a renewable cartridge fuse, which is the result of very extensive laboratory experiments and the design of engineers of national reputation.

The mechanical construction of the product involves several features not met with in previous products, one of the primary features, which reduces the shipping expense, being the extreme light weight, due to the fact that aluminum is used for all of the parts, which do not carry current. In the higher capacity types a construction is employed to keep the knife blade paralelled at all times. The fibre shell used in this product is constructed of the very best grade of gray horn fibre which is the highest class material of this kind obtainable.

As the electrical characteristics of a product of this nature are of primary importance, this company spent considerable time in developing a proper renewal which would not burn up or blow up the shell under every day service conditions, and are offering to the trade a renewable cartridge fuse whose electrical characteristics and operation agree in every respect with the specifications of the National Board of Fire Underwriters, whose rulings govern all devices of this kind.

The manufacturers say that some of the largest factories, office buildings, mills, and railroad companies in the country have adopted this fuse as their standard, some of them having sufficient of these fuses installed at this time to effect a saving of thousands of dollars per annum.

The company is just getting out a new catalogue listing their complete line, which they will be glad to send free on request to their general office or to any of their sales offices, as listed in the Company's advertisements elsewhere in this issue.

Dope Sheet.

WOODWORKING MACHINERY POWER TO DRIVE SAWS.

Name of tool	Material	R.P.M. Driving shaft	R.P.M. Tool	Ft.P.M. Tool	CUT Width	CUT Depth	Cu. In. P. Sec.	HORSE - POWER No Load	HORSE - POWER Start	HORSE - POWER Ave.	Useful H.P.Ave.
12" Circular Belted											
to 5 H.P. Motor	Ash		2915	9165		2½"		1.5	6.3	5.7	4.2
4" Stroke Jig Saw	Ash					1"			3.2	1.0	
Belted to 3 H.P. Motor	Ash					4"			3.2	1.1	
Band Saw Belted to	Spruce			3720		6"		1.2	5.1	2.6	1.4
3 H.P. Motor	Spruce			3720		2"		1.2	5.1	1.9	0.7
	Lignum Vitae			3720		3½"		1.8	5.1	3.2	2.0
Tip Table Saw	Dry Oak	650			2½" X 10"			3.7		10	6.3
Band Saw	Oak					3"		0.4		3.2	2.8
Rip & Groove Saw	Dry Oak	600			2½" X 10"			3.7		10	6.3
Small Tip Saw	Dry Oak	780	750		2½" X 10"			3.7		10	6.3
Tip Table Saw	Dry Oak	780			2½" X 10"			3.7		10	6.3
Band Saw	Dry Oak					4½"		.72		2.24	1.52
Jig Saw	Cherry	1000				1¾"		.48		.67	0.19
Cross-Cut Saw	Poplar	680	800		1¼" X 14"			.48		1	0.52
	Poplar	720			1¼" X 14"			.48		1	0.52
Cross-Cut and Rip Saw					Speed of Feed P.M.						
Belted to 10 H.P. Shunt	Hickory	528	2084		3"	2' - 1"				4.4	
Motor Saw 1/8"Th.12¾"Dia.	Pine				3"	9' - 2"				4.4	
Old Gainer		630	M'C'H					3.8		6	2.2
New Gainer	Medium Oak	700	M'C'H		½" X 4" X 9"			3.8		5.9	2.1
Cut Gainer	Green Oak	250			1" X 4" X 12"			4.7		5.4	0.7
New Gainer		400						4.7		5.4	0.7
Gainer	Dry Oak	350MCH	410		1½" X 2"			.53		2.5	1.97
Old Lathe		490						1.83		5.11	3.28
Wood Lathe		850						1.83		5.1	3.27
Wood Lathe	Pine	800	1000			2"		.83		2.9	2.27

WOODWORKING MACHINERY POWER TO DRIVE SAWS.

Name of Tool	Material	R.P.M. Driving Shaft	R.P.M. Tool	CUT Width	CUT Depth	Cu.In. P.Sec.	HORSE - POWER No.Load	HORSE - POWER Max	HORSE - POWER Ave.	Useful H.P.(Ave)
Self Feeding Rip Saw			2135				1.75			
25" Saw	Oak		2100	¼"	6½"	4.6	1.75	29.1	18.2	16.45
Band Saw		480	5470				1.4			
1½" X 23'-6" Blade	Oak						1.4	5.4	4.8	3.4
	Oak						1.4	6.6	5.4	4.0
Band Saw ½"X 18' Blade		520	4900				1.0			
	White Pine						1.0	6.0	3.0	2.0
Circular Rip Saw			1800				1.5			
28" Saw	Oak			¼"	9½"	6.73	1.5	24.5	15.5	14.0
Circular Rip Saw			2040				1.5			
22" Saw	Oak			¼"	6¼"	5.0	1.5	19.0	10.0	8.5
Rip & Cross-Cut Saw							1.5			
	Oak			3/16"	3½"	2.36	1.5	7.5	7.0	5.5
Cut-Off Saw 36" Saw			1250				1.5			
	Oak			¼"	10"	5.0	1.5	12.0	10.8	9.3
Bracket Saw	Green Oak	400	425	8" X 12"			7		1.6	.9
Cut-Off Saw	Green Oak	670	750	4½" X 8"			4.7		9.7	5.0
New Cut-Off Saw	Green Oak	425					3.5		9.7	6.2
Rip Saw	Oak			4" Cut			3.5		8.5	5.0
Grooving Saw	Oak		1025	4" Cut			3.5		8.5	5.0
	Green Oak			1"X 1"Groove					7.7	
Edgeing Saw	Green Oak		2400	3"			3.6		19.6	16.0
Spring Saw	Green Oak	665		3"			3.6		19.6	16.0
Band Saw	Dry Oak			4½"			0.8		3.1	2.3
Rip Saw	Oak			4"			3.5		3.5	5.0
Rip & Gr. Saw	Oak			4"			3.5		8.5	5.0
Old Rip Saw	Green Oak			3"			3.6		19.6	16.0
Outside Saw	Green Oak			4½" X 8"			4.7		9.4	4.7

WOODWORKING MACHINERY POWER TO DRIVE SAWS.

Name of tool	Material	R.P.M. Driving Shaft	R.P.M. Tool	Ft.P.Min. of Tool	CUT Width	CUT Depth	Cu.In. P.Sec	HORSE - POWER No.Load	HORSE - POWER Max	HORSE - POWER Ave	Useful H.P (Ave)
Small Lathe		625						.4		1.65	1.25
Small Sticker	Poplar	1000 MCH			2½" X 13/16			2.3		2.9	0.6
Large Sticker	Poplar	990 MCH	925		½" X 6"X8"			4.6		7.75	3.15
Grinder		250		Grinding Saws & Knives				3.4		5.5	2.1
Small Grinder		310						.3		1.1	.8
Old Mill Dresser		570						16		35.5	19.5
New Mill Dresser	Rough Gr.Oak	430			4½"X8½"X10"			16		35	19
Matcher	Geo. Pine		800	3½"X12½"Fin.2¾"X11½"				14		31	17
Jointer	Hickory	3300			1¾"X6"X1/8"Cut			.76		2.24	1.48
Sand Paper Machine	Poplar	600	585		7/8" X 18"			3.8		8.4	4.6
Double Fan Go		475	1500	M'C'H				5.9		5.9	---
Fan 55" L		1300 MCH						22.16		22.16	---
Fan 55" R		1250 MCH	1120					22.16		22.16	---
Large Band Saw		480						2.50			
	Oak				5/64"	12½"	0.82	2.50	6.7	5.9	3.4
Small Band Saw	Oak	540			5/64"	3¾"	0.36	2.39	3.5	3.1	0.71
	Oak				5/64"	3¼"	1.27	2.39	6.1	5.3	3.91
	Oak				5/64"	5"	1.11	2.39	6.3	5.3	3.91
Cross-Cut Saw 15"Saw		850	2900					1.1			
	Oak				3/16"	4½"	1.04	1.1	4.65	4.0	2.9
Large Cross-Cut Saw								6.75			
37" Saw	Oak				½"	10½"		6.75	29.7	18.3	11 55
	Oak				¼"	6½"	7.85	6.75	16.5	15.8	9.05
Rip Saw 15" Saw		700						1.75			
	Oak				½"	2½"	5.64	1.75	16.6	16.4	14 65
	Oak				½"	3½"	5.25	1.75	19.2	15 6	13 85

WOODWORKING MACHINERY POWER TO DRIVE SAWS.

Name of Tool	Material	R.P.M. Driving shaft	R.P.M. Tool	Ft. P. M. of Tool.	CUT Depth	HORSE -POWER No.Load	HORSE -POWER Start	HORSE -POWER Ave.	Useful H.P.(Ave)
8"Circular Rip Belted	Hickory		1975	4136	1½"	1.3		3.2	1.9
To 5 H.P. Motor	Pine		1975	4136	1"	1.3		2.4	1.1
	Spruce		3140	6575	2"	1.3		3.8	2.5
8"Circular Cutoff	Maple		2700	5651	½"	1.9	5.1	2.4	0.5
Belted to 5 H.P. Motor	Maple		3040	6366	1"	1.9	5.1	3.8	1.9
8"Dado Circular Slit									
Belted to 5 H.P. Motor	Pine		2510	5266	½"	1.9	5.0	2.4	0.5
8"Circular Cut-Off									
Belted to 5 H.P. Motor	Mahogany		2760	5797	1"	1.6	5.8	2.8	1.2
8"Circulat Cut-Off (Saw									
Dull)Belted to 5 H.P.Motor	Pine		2760	5797	7/8"	1.6	5.8	3.5	1.9
10"Circulat Rip(Fed Hard)	Hickory		2110	5526	2-1/8"	1.1	4.6	7.3	6.2
Belted to 5 H.P.	Hickory		2110	5526	2½"	1.1	4.6	5.4	4.3
Motor (Feed Easy)	Hickory		2110	5526	½"	1.1	4.6	2.7	1.6
10"Circular Cut Off	Maple		2450	6413	2"	1.6	6.4	2.5	0.9
Belted to 5 H.P. Motor	Spruce		2450	6413	1"	1.6	6.4	1.9	0.3
10"Circular Rip Belt-	Pine		2640	6920	¾"	2.9	5.2	3.2	0.3
ed to 5 H.P. Motor	Maple		2640	6920	1¼"	2.9	5.2	3.5	0.6
10"Circular Rip Belt-									
ed to 5 H.P. Motor	Spruce(Wet)		2100	5697	2"	1.3	6.0	8	6.7
14"Circular Cut Off	Ash		2100	7698	3"	2.6	7.3	9.3	6.7
Belted to 7½ H.P. Motor	Spruce		2100	7698	2"	2.6	7.3	8.7	6.1
17"Circular Rip Belt-	Spruce		2150	9567	3"	2.6	10.7	9.3	6.7
ed to 7½ h.p. Motor.	Spruce		2150	9567	1"	2.6	10.7	4.0	1.4
18"Circular Rip Belted									
7½ H.P. Motor	Ash		2100	9895	7"	1.3	15.4	10.2	8.9
Cut-Off	Ash		2100	9895	4"	1.3	15.4	9.0	7.7

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

Parallel Operation of Axle Equipments.

The paper by Mr. Roger T. Smith, of the Great Western Railway of England, discussed at the last meeting of the Car Lighting Club brings up the question of operating various axle equipments in parallel.

It is pretty generally recognized by most of the roads that it is necessary to have an individual generating unit on each car so as to provide for flexibility of system, which is entirely impossible where head-end or "brake-vehicle" system as advocated by Mr. Smith, is employed. Occasionally, however, on account of failure of an axle equipment it becomes necessary to connect that car to an adjacent car having an equipment of approximately the same voltage. Even when the voltage of the two equipments, however, are not exactly the same, the lamp regulator in the car in trouble may be able to take care of this difference and provide normal lamp voltage, as did the regulator on the private car reported in one of the "Practical Stunts" last month. There will, however, be a heavy rush of current into the low battery, which may cause a reduction in lamp voltage on both cars.

As to the operation of axle equipments which are operating normally and in good condition, some discretion must be employed. The troubles which are always experienced in operating two or more batteries in parallel, that is, one consuming both the major part of the load on discharge and taking the biggest part of the current on charge will be experienced. Each generator will, however, tend to keep its own storage battery in good condition on account of the voltage drop in transmitting to a battery in a distant car.

This is obviously true of constant current regulators wherein the regulator current is the sum of the lamp current and battery charging current, for if train line is connected to the battery side of the regulator coil the batteries will all be directly in parallel on the train line as a common bus-bar, and a balancing current tending to equalize voltage of all batteries will flow over the train line. This is essentially the same as ordinary parallel operation of batteries and has all of the inherent faults connected with this system.

The train line connection should always be made direct to the battery and should not include the regulator coil. Where it is connected to the generator side of the regulator coil, however, the regulator will operate so as to cause the sum of the lamp current and battery current to be equal to the normal setting of the regulator regardless of what the generator voltage developed is. When two or more constant current regulators are operated in parallel in this manner, due to various reasons, the storage battery on one of the equipments may become more nearly charged than that of another equipment, the voltage of the generator whose battery is more nearly charged will, incidentally, be higher than the other generator in parallel with it. Accordingly the generator of higher voltage will carry a part of the load of the other machine; in fact, this current delivered to the other car will rise to such a value that the voltage drop over the train line is equal to the difference in charging voltage of the two storage batteries.

Where battery current regulators are employed great discretion should be used in operating them in parallel for the difference in battery charging voltage may cause serious unbalancing of the generators in the train. The high voltage generator, in extreme cases, may not only assume the load of one or more of the other machines, but may actually cause current to flow through the armature of the low voltage machine in the reverse direction, driving that generator as a motor. This is true of all battery current regulators, and they should never be operated in parallel except when absolutely necessary.

Change of Voltage of Car Lighting Equipment.

We have seen how the conversion from 110 volts to 60 volts operation in headend equipment has been readily effected by simply increasing the generator field variable resistance and placing a shunt across the compound field windings but the conversion of axle equipments from 60 to 30 volt operation or vice versa, has been given little consideration.

The "Practical Stunt" submitted in this issue by Mr. Knight, of B. & A. R. R., is, we believe, one of fundamental importance to railway car lighting men. It may become advisable on account of operating conditions or changes in policy to change the voltage of axle lighting equipment from 60 to 30 volts and then in other cases, changing 30 volt equipments to operate at 60 volts. With any current regulator either of the constant current type or of the battery current type or any combination of the two, this change can be readily effected by simply changing the voltage coil or coils employed in connection with the equipment, provided the current flow in the armature does not exceed that for which the equipment was originally designed.

In changing from 60 to 30 volts with a Bliss Bucker

type equipment the change is readily effected as Mr. Knight suggests by merely cutting out one-half of the storage cells and replacing the 60 volt lifting coil of the automatic switch with a 30 volt coil. As this regulator is one of the battery current type it will regulate to controll the current flow to certain definite values regardless of the voltage generated. As the lamp current will be doubled by reducing the voltage one-half it will undoubtedly become necessary to set the adjustable resistance across the series field rather high in order to provide suitable increase in current flow.

The battery current characteristic, that is, the ratio of battery current flow to train speed above cutting in speed, will be somewhat lower, although the extent of change in this characteristic will depend entirely upon the various points of magnetic saturation at which the generator field, the series bucker, and the bucker motor field were all originally designed for operation at 60 volts. The battery current flowing at the average train speed of that particular run should be very carefully observed, and if it is not sufficient to maintain the battery in a properly changed condition, the adjustable resistance across the series field should be set at the value which will so do.

For constant current regulators the change is equally simple. The regulator will operate the generator field resistance so as to cause the proper amount of current to flow whether it be at 60 volts or 30 volts, but as in the case of the bucker type equipment, a new setting of the regulator will undoubtedly be required since the lamp current consumed is double. In all cases where the voltage of operation is reduced great care must be taken to provide that the generator current under the new conditions of operation does not exceed the normal current carrying capacity of the armature.

In view of the great reduction of lamp current effected by the advent of the tungsten light, however, it seems very probable that this change from 60 volt operation to 30 volt operation can be easily effected without overloading the generator armature. It will be found that the equipment will cut-in at somewhat lower speeds depending upon the magnetic characteristics of the generator, although this will not be anything like half the cutting-in speed at 60 volts.

The Stop Charge Relay.

The article on page 254 of this issue, entitled "The Ampere Hour Meter in Car Lighting Service," gives a fairly good idea of some conditions of operation in axle lighting service. It shows in each case that there is a wide variation in the battery discharge experienced from week to week. This, however, only emphasizes the fact that it is impossible to set the generator regulator with any degree of accuracy. It must be set high enough to take care of average discharge and allow a liberal excess for emergencies. Hence the development of the stop charge relay, which is designed to prevent overcharging.

The data of these three tests does not show the superiority of one equipment and the weakness of another; in fact, all three tests may have been made on the same type of equipment, but it does show very strongly the great need of very careful supervision in the setting and maintenance of stop charge relays.

SOLDER FOR ALUMINUM.

According to a French patent a good solder is composed of an alloy of one part tin and two parts zinc, to which five per cent of its weight of cadmium is added. These proportions are variable. The solder can be used without a flux.

Association News

Semi Annual Convention.

Semi annual convention of the Association will be held at Atlantic City, Tuesday, June 11th, the day preceding the opening of the M. B. C. Convention. Members will then have an opportunity of viewing the exhibits of the various supply companies and will also have the opportunity of attending meetings of the M. C. B. Association.

The various committees have been doing some good work and will make progress reports at this time..

Annual Convention.

The annual convention of the Association will be held October 21-25 at the La Salle Hotel, Chicago, Ill. This is a few weeks earlier than last year on account of the coming presidential election.

Volume No. 1 of Proceedings.

We have on hand quite a supply of cloth bound copies of volume No. 1 of the Proceedings. You recall these were originally issued in paper covers. Volumes 2 and 3, however, have been issued cloth bound. Any one of the members of the Association preferring to have a cloth bound copy of volume No. 1 can procure same on request to the RAILWAY ELECTRICAL ENGINEER, 106 N. La Salle St., Chicago. A charge of 15c each will be made to cover postage and packing.

The Secretary reports that Volume No. 4, of the Proceedings, 1911, will be ready for distribution the latter part of the month.

CAR LIGHTING CLUB FOR APRIL.

The subject of the April meeting of the Car Lighting Club will be the "Planning and Equipping of Railroad Shops," by George W. Cravens.

Mr. Cravens has had a great deal of experience in this work both from the manufacturer's viewpoint of design and from railroad man's viewpoint of operation, so we ought to learn a good many things about railroad shop motor equipment at this meeting.

The May meeting of the club will be in charge of H. G. Myers with the subject of "Troubles and How to Shoot 'em."

We all have lots of troubles and it does us good to tell the other fellow about them. Maybe when we get through telling them we may see them from a little different viewpoint ourselves and we are benefited, but at any rate, it does the other fellow good to learn of our troubles and mistakes. Then if he is the right kind of a fellow he will reciprocate and we will profit by his troubles.

Be sure and plan to attend the May meeting even if you have to come 500 miles to do it. If you can't be there, however, send your troubles to Mr. H. G. Myers, Elec. Fore. Santa Fe R. R., 18th Street Yards, Chicago, Ills., and he will bring them up at the meeting.

TRAIN LIGHTING IN EUROPE.

The March meeting of the Car Lighting Club was devoted to a discussion of the paper by Mr. R. T. Smith recently published in the RAILWAY ELECTRICAL ENGINEER on "Electrical Lighting of Railway Trains in England." Our Secretary had communicated with other European railway men and had some interesting notes to supplement Mr. Smith's excellent paper. The subject was briefly outlined by Sec. Wray, bringing out the chief points of Mr. Smith's paper. He said that the conditions of operation in Europe were so different from those in America that it was rather hard to draw comparisons. There were however many points brought out by Mr.

Smith which offered some valuable sugestions to American car lighting engineers. One of these suggestions is found in what the author says regarding white head linings of car ceilings. This will materially improve the general illumination of the car as well as increase the visual efficiency of the passengers by eliminating the strong contrast which occurs when a lamp is observed against a dark back ground.

Another interesting fact is found in the use of ball bearings although this is now being introduced into American practice.

It was noted that the train line connectors were placed just above the car floor, an extra connector being placed on each side of the bumpers, thus providing a duplicate connection between cars. One male connector, however, was fastened permanently to each end of each car, likewise a female corresponding. It was assumed that when a car was disconnected there was a receptacle to place the male connector in so that it would not dangle loosely. This seems to offer some food for thought on the part of American car lighting men.

As to the applicability of the brake-vehicle method to American railway practice, it would seem that this involves all of the limitations of the headend system of operation as employed in this country although in the "brake-vehicle" system there are three and sometimes four generators in a train so that the diner, which is a "self lit" car may be cut out if necessary. The same practice is employed in many of our head-end trains in which there are either storage batteries on every car or there are three or four batteries located on various cars throughout the train so that in case the train line is cut in two to remove one car, the lights are maintained by the storage battery auxiliary.

By adopting the brake-vehicle method as Mr. Smith outlines it, the one great advantage of the axle system or "self-lit" system, as it is known in England, is lost. That is, it is no longer possible to operate each and every car as an independent unit; they must then be operated as a solid block train or nearly so, as our head-end block trains are in this country.

As to the cost of electric lighting of cars given by Mr. Smith, there was such a great discrepancy between these figures and anything which is obtained in this country that the Secretary was instructed to write Mr. Smith for a detailed statement as to the items which go to make up the costs so as to provide a more comprehensive analysis of the situation for the benefit of car lighting engineers in this country.

Mr. Beck of the Electric Storage Battery Co., said that the life of any storage battery depended chiefly upon two things: how much it is used, and how well it is handled.

The more a battery is used the less its effective life and the fewer number of charges and discharges the battery receives the longer its effective life. He said that in central station work, where a battery receives but a few charges and discharges a ten year life is common practice, while in heavy traction work where the battery receives a great many short, but heavy, charges and discharges, there is but about three years life obtained.

In either central station or street railway traction service batteries receive better care than they do in railway car lighting service. Traction batteries receive heavy duty but good care; whereas, with car lighting cells the duty they are called upon to perform is comparatively small, yet the care which it seems possible to give them is but of a limited and of a rather unsatisfactory nature. The author, Mr. Smith, in speaking of the ideal life which a storage battery in car lighting service leads, seems to overlook the factor of human attention that the battery must receive and rather gives emphasis to the apparent ideal conditions of short discharges followed by immediate charge.

Mr. Beck said that the author seems to depend entirely on cutting off charge by voltage method. He said that while it might be true that the equipment would operate satisfactorily at normal temperature, the cells might easily become a trifle warm and lower the charging voltage to such a point that the stop charge relay would not work.

Mr. Beck said that he did not believe that a device could be made which would insure perfect operation of the storage battery. There must always be a great deal of the human element supplied in the operation of any battery. Organization and personal attention are far more important than any automatic system for battery control, although the latter may be advantageously employed. He said that he believed the system advocated by Mr. Smith has complications which do not entirely warrant the good results they may accomplish in providing an adjustable feature in taper charge.

In regard to the stratification of electrolyte of which the author speaks, Mr. Beck said that he believed that this was really of less importance than the paper would indicate notwithstanding the fact that there are many installations at the present time in which air is forced into the bottom of the cells for the purpose of stirring up the electrolyte and breaking up the stratification of the acid. There are many examples of storage battery operation which seem to indicate that stratification does not injure the plates.

Some interlocking railway signal batteries on both the Pennsylvania and the B. & O. Rys. are so arranged as to be continually charged by gravity primary cells, storage battery being floated across the primary cell at a voltage from 2.1—2.15 volts per cell. In this service the plates never gas, but they are charged practically continuously and the acid stratification is rarely disturbed, yet these plates are of long life. Some of them have been in service at the present time for 14 years. This would indicate that stratification of electrolyte in a storage battery is not so serious a matter as the author considers it.

Mr. Frost of the Santa Fe said that undoubtedly one of the reasons why the cost of operation given by Mr. Smith was so low was because of the fact that the entire equipment was new, and there were very few renewals of battery plates or generator parts necessary.

Mr. Miller of the Safety Car Heating & Lighting Co., said that it was a much mooted question as to whether or not anything should be charged for hauling of equipment, but he thought there should. There are three things which enter into the cost of train operation. First, the weight of the train. Second, the weight of revenue load. Third the ratio of revenue load to total weight of train. He said there was a great difference in actual cost of haul between high and low train speed operation. The greater air and journal friction at high speed increased the cost of operation per ton mile in passenger service. As to what items of total cost of operation should be included in the charge against haulage of equipment, Mr. Miller said that maintenance of way and of rolling stock, as well as all salaries of crew and other overhead expenses did not enter into consideration at all. The only items which could justly be charged to haulage of equipment, would be coal and water. He cited a figure compiled by one of the large railroads of .83 mils per ton mile, coal at $1.50 a ton. Of this figure water comprised .3 of one mil. This figure was subsequently raised to one mil per ton mile.

The Ampere Hour Meter in Car Lighting Service

Since the first issue of this publication we have earnestly advocated the installation of ampere hour meters in connection with car lighting equipments, and it is gratifying to be able to offer something more in the way of actual service where the meters have been used.

The following curves, which are taken from test meters placed on three cars operating on one of the large western roads, illustrates very well both the advantage of installing ampere hour meters and at the same time

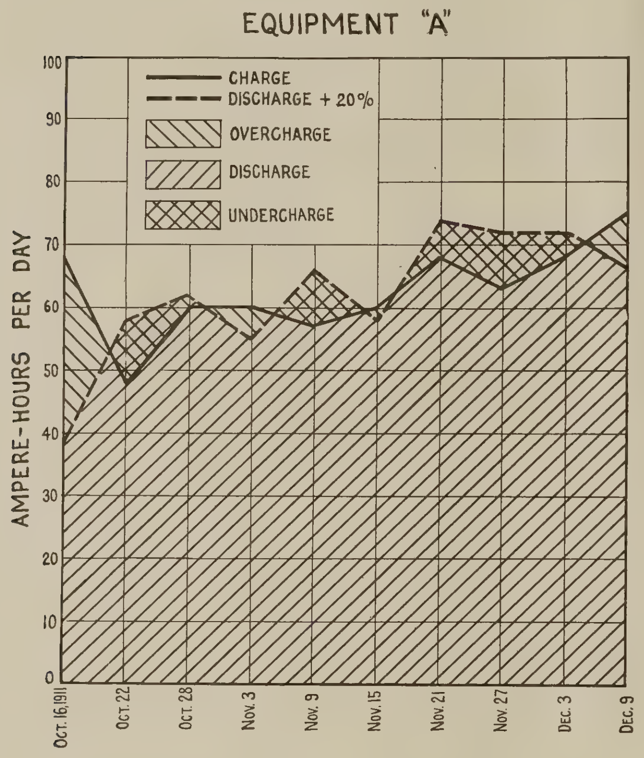


Fig. 1. Average Daily Charge and Discharge Equip. A.

shows what results may be obtained by intelligent adjustment and maintenance of stop charge relay and generator regulator.

All the equipments are on overland trains of 5 and 6 days run. In all cases the ampere hour charge and discharge read at the end of each run has been reduced to a daily basis. The discharge curve as plotted has been increased 20% which we arbitrarily assume as the right amount to make up for battery losses. As a matter of fact, there is, in addition to the loss in ampere hours due to battery inefficiency, a constant loss of charge due to local action in the battery known as leakage, which must be provided for on charge. Any grounds on the equipment even though very slight also cause a constant depletion of the battery charge. As these equipments are operated every day, however, the 20% addition to discharge values is deemed sufficiently accurate.

On car "A" it should be noted that the stop charge relay and generator regulator were evidently properly adjusted as the overcharging is just about sufficient on some days to make up for the lack of overcharge on other days.

On equipment "B" the stop charge relay and generator regulator are both set a trifle too high as there is considerable overcharging. This, however, is not of a destructive nature and, for the most part, may be necessary on account of the uncertainty of condition of operation as shown by variation in battery charge and discharge readings.

Equipment "C" however, is an example of chronic overcharging and should be immediately corrected either by a reduction of the setting of the stop charge relay or of the regulator, or both. An average overcharge of 125 ampere hours per day as was experienced over the period of from November 22nd to December 22nd is enough to cause the destruction of most any battery, either by boiling of the active material or by causing the plates to grow excessively, or both. It should be noted that on December 2nd the battery was reported to be very hot, but there is no question whatever that, had the temperature of the battery been reported every day during this month, it would have been found to be well above the danger point of 110° F. every day.

These curves impressively demonstrate both the application of and the crying need for an ampere hour meter in connection with car lighting equipment. It is the writer's firm conviction that there should be an ampere hour meter installed permanently in connection with every storage battery operated in car lighting service. Even in straight storage equipment which is the most easily operated as regarding overcharging, the ampere hour meter will save its cost within a few months in reduced charging current bills.

In headend service it serves as an indication both as to the available capacity left in the battery and gives the train electrician an idea as to what charge will be re-

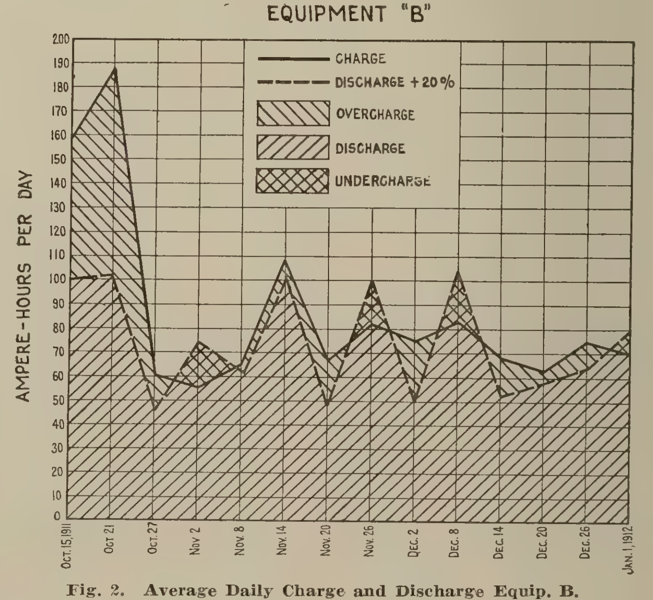


Fig. 2. Average Daily Charge and Discharge Equip. B.

quired to bring his batteries up to full capacity. In axle lighting service where conditions are much more uncertain and the batteries receive less of the personal attention than in either of the other two classes of service, the application of an ampere hour meter becomes of far

greater importance. One can easily appreciate how conditions as existed in the operation of the equipment on car "C" will result in very short battery life and general dissatisfaction. An ampere hour meter on such an equipment would soon indicate the exact situation so that it could be corrected.

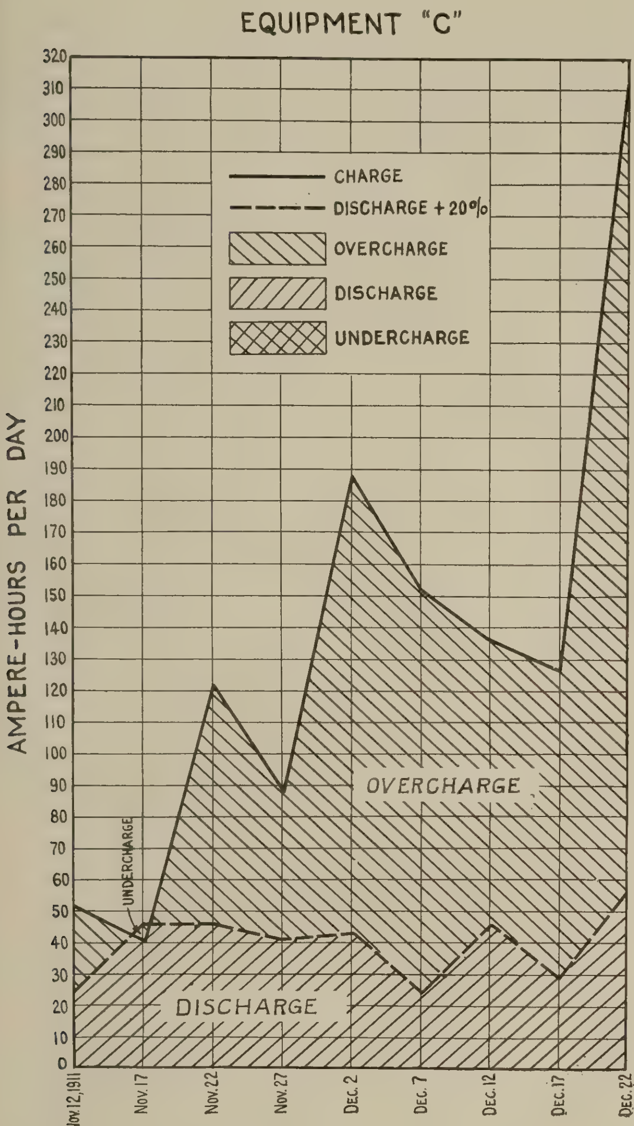


Fig. 3. Average Daily Charge and Discharge Equip. C.

The conclusions to be drawn from these three tests are not, as might be considered by some, of such a nature as to condemn one type of axle equipment and exalt another. In fact, the same results might easily be experienced with three equipments of exactly the same type if operated under conditions similar to those tested. These tests do however, make a powerful appeal first, for the proper setting of the generator regulator and stop charge relay, and second for consistent and intelligent supervision in the operation of axle equipments.

It was reported that in each of the three equipments tested, the stop charge relay was adjusted to operate at 44 volts. In the case of "C" equipment, however, there seems to have been some trouble in maintaining the proper setting of the stop charge relay, for on November 22nd it was found that this did not operate until the voltage rose to 46 volts. The setting was accordingly reduced to 44 volts, but on December 2nd it was found that the adjustment had again changed and the relay had to be again reduced from 46 volts to 44 volts.

NEW EQUIPMENT ON ILLINOIS CENTRAL R. R.

Illinois Central Railroad has just completed specifications for 98 new passenger cars consisting of 27 baggage cars, 60 coaches, 8 diners, 3 parlor cars.

Electric lighting equipment is to be installed throughout, there being no auxiliary light whatsoever supplied except candle lamps.

Type D, 30 volt Gould axle lighting equipment with link suspension for generators is to be used on all cars. 25 Edison nickel iron cells of type "A 8 H," 300 ampere hours are to be placed on each car. The new type cells having extra heavy lugs and binding posts with a 2-inch clearance at the bottom and with extra high space above plates are specified. These 25 cells are to be arranged in trays of three cells each, the last tray having but one cell.

All battery boxes are of steel, lined with 1-inch matched wood thoroughly paraffined on the inside. All lamp regulators are placed in the car lockers except on the diners where they are hung from the car frame.

Standard Pullman switchboard is to be employed in all cases, having one train line switch, one main lamp switch and one battery switch, in addition to the usual individual circuit snap switches. Battery switch is locked with a cotter key so that it cannot be opened by any one except the yard men on testing the equipment. Edison cutouts are supplied on all boards, with separate D. P. snap switches (except diners which have 3—*00 train wires).

All cars are equipped with 2, No. 2 train lines using Delta Star 3G receptacles except diners which have 3, No. 00 train lines as the latter occasionally get into headend service. On all cars, however, the train lines are run in 2-inch conduit so that even the cars which are equipped with only 2, No. 2 train lines, three heavy train lines can be easily installed if necessary.

40 watt tungsten lamps are to be used almost exclusively, these being placed in the center deck position as follows: Baggage and express cars, 6—40 watt lamps, coaches 10—40 watt lamps, diner 8 40 watt lamps, 32 15 watt lamps, observation cars 8 40 watt, 30 15 watt. For lighting the vestibule there is a 15 watt lamp placed over each trap door. This is mounted in a nickel flush receptacle so that it throws the light down on the bottom step.

Jandus bracket fans will be installed in each of the cars except the baggage cars. These fans are placed on separate circuits so that the lamp switch can be open in the day time and the lamp regulator disconnected without disconnecting the fans.

All cars will have 6½ inch straight rough turned axles where the axle pulley is mounted. All axle pullies will be of the Oneida Keystone R. R. flanged type 21 inch in diameter, 7½ inch bore and 8 inch face. Oneida corrugated bushings will be supplied.

The new Gould disconnecting terminal box is to be applied at the terminal board under all cars so that the generator wires may be easily disconnected or connected by any truck man when changing wheels or in case of a derailment.

RAILWAY FANS.

On the Wings of the Wind is the title of a booklet just issued by the Adams Bagnall Electric Co., which describes various types of railroad fans manufactured by that Company. It shows the erect and inverted types of bracket adjustable fans in which the fans are removable from the base. It also shows the gyrofan and twin oscillating type for car service.

This booklet is of special interest to the railway man and can be procured by a post card request.

Electric Locomotives for Panama Canal

Now that the opening of the canal is but a little over a year in the future, some of the details of operation become of interest. It has been decided to pass all ships through the locks of the canal by means of electric locomotives, the ships' own power in no case being employed for propulsion in the vicinity of the locks. There will be four locomotives applied to each ship as it passes through the canal; two for towing the ship, one on each side, and two at the rear to act as brakes in bringing the ship to a standstill in the locks, and to assist in keeping it in the center of the channel.

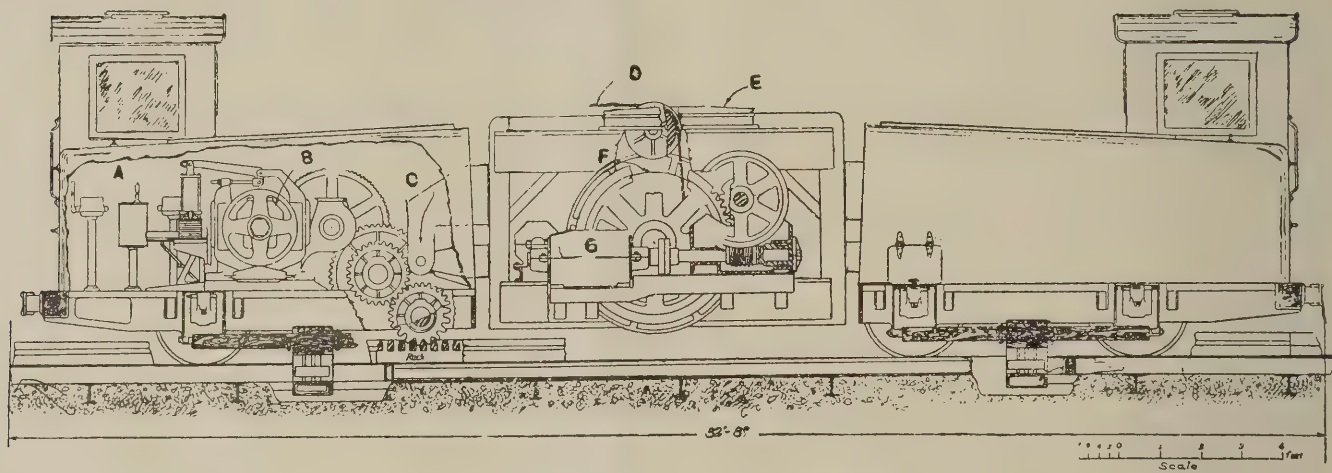


Fig. 1. Side Elevation of Electric Locomotive.

The contract for building one of these locomotives to be tried out in this service has been awarded to the General Electric Company. This locomotive will be subject to rigorous practical tests and if found satisfactory, 39 more will be ordered from the same company. The system is patented by Edward Schildhauer, and the commission has the right to use the machines covered by this patent without making any compensation therefor.

The speed of the ship in passing through the locks will be 2 m. p. h. The ship will come to a stop in the forbay of the lock, where the four cables will be attached to it, two forward on either side, and two aft. The four locomotives which control the vessel will run on a five-foot gauge track mounted on the lock walls on either side. When towing vessels, or climbing the steep inclines between locks, the locomotives will operate on a rack rail. When running light, returning for a new vessel, the locomotive will operate at 5 m. p. h. and the gear and rack mechanism will not be employed. The grade on the inclines between locks will be a rise of 1 ft. in 2 ft., with virtical curves of 100 ft. radius and horizontal curves of 200 ft. radius. It is hardly what one would expect, but the greatest load which the traction motors are called upon to perorm is not in towing vessels, but when the locomotive without load ascends the steep inclines between lock levels.

Since, when operating under load conditions, the gear and rack mechanism is employed, the draw-bar pull of the locomotive does not depend on the rail friction and weight of locomotive, so these locomotives will be built as light as possible consistent with good engineering design.

The illustrations shown herewith are taken from the specifications for the equipment, no photographs being available at this time. The locomotives will be equipped with a motor-driven windlass for hauling in and paying out the towing line; also a high speed motor-driven attachment for coiling the towing line when out of service. A safety device is supplied in connection with the windlass which provides that

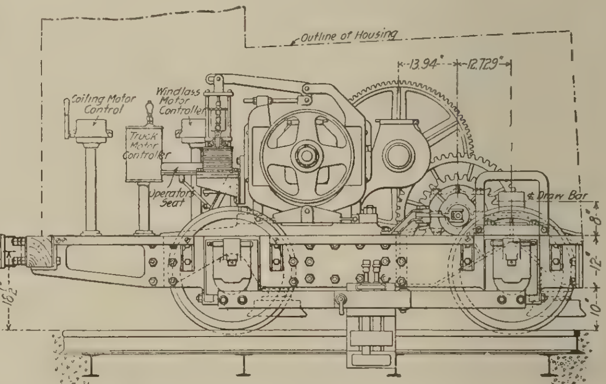


Fig. 2. Side View Detail of Traction Gear and Truck.

the tension on the towing line shall never exceed 25,000 lbs. This prevents the possibility of damage to either locomotive or ship in case of accident.

The towing line will be of plow steel wire rope 1 inch in diameter and will be composed of 6 strands of 37 wires each, with a hemp center, these wires to have a tensil strength of not less than 22,500 lbs. per sq. in. The ultimate breaking strength of the cable shall not be less than 70,000 lbs. Length of the line is to be 225 ft. and no splicing will be allowed except at the loop.

This towing windlass drum is mounted on the central 9 ft. body, flexibly connected between the two trucks. The traction motors with rack gearing mechanism are mounted on two trucks, as shown in the accompanying illustrations.

There are four motors supplied, two on each truck, and these with their rack mechanism are identical in each case.

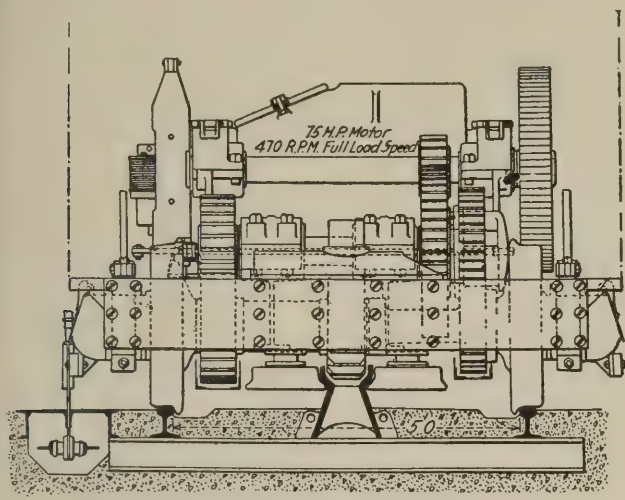


Fig. 3. End Elevation of Traction Gear and Truck.

No type of motor is specified, but it is required that they shall be such as have been successfully applied in railway or steel rolling mill service.

These motors will be three phase, 25 cycle, 220 volt, high torque railway or mill type, totally enclosed and moisture proof. Those for traction purposes have a full speed torque of 840 lbs. at 1 ft. radius, a

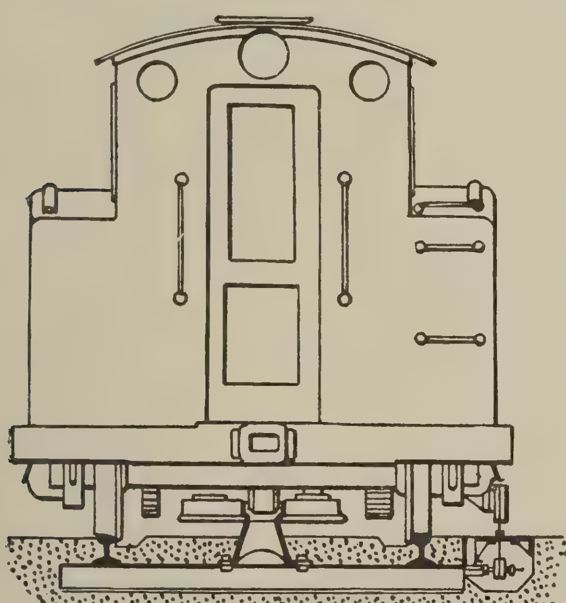


Fig. 4. End View of Cab.

full load speed of not less than 470 r. p. m. and be capable of developing not less than 75% overload for a period of one minute. The windlass motor shall have a full speed torque of 120 lbs. at 1 ft. radius and be capable of handling 50% overload for one minute, full load speed 660 r. p. m. The motor for coiling the cable shall have 30 lbs. torque at 1 ft. radius with 50% overload for one minute, and a full load speed of 630 r. p. m. Three phase current will be collected by means of plows from rail conductors in an open conduit. Each of these plows will carry two contact shoes, one for each of two phases which will make contact on two conductor rails properly insulated and located on the sides of the open conduit. The two track-rails will form the third conductor of the three phase circuit.

The severe temperature conditions in the Canal Zone, which, together with high humidity, have a marked deteriorating effect on insulation and all metal parts. Accordingly special attention has been given this phase of the problem to avoid as far as possible trouble from these sources.

Fig. 1 shows a side view of the locomotive with part of the housing removed so as to illustrate more clearly the detail construction of the locomotive. The following is a key to letter references: A, controllers; B, traction motor; C, universal connection; D, towing line; E, turret; F, slip drum; G, winding motor; H, collecting plow.

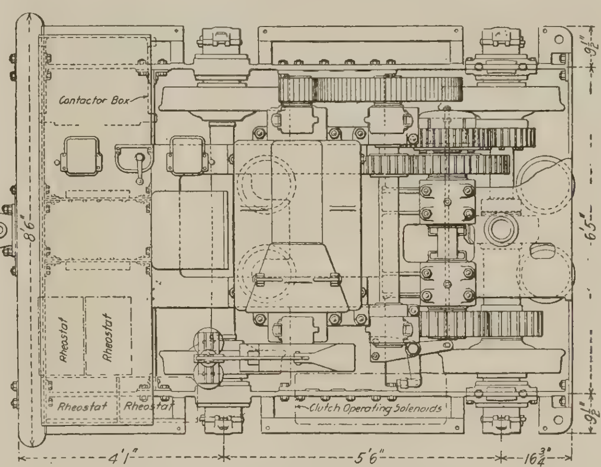


Fig. 5. Plan Detail of Traction Gear.

ELECTRICAL NIGHT, NEW YORK R. R. CLUB.

For the past seven years one of the meetings each year of the N. Y. R. R. Club has been devoted to Electrification. This year's meeting, while not so full of acrimonious discussion as the earlier meetings were, indicated very strongly the marked progress which has been made in electification during the past year.

Mr. W. S. Murray of the New Haven and Mr. Katé of the New York Central presented conclusive operating data which fully established the fact that both single-phase and a direct-current systems are reliable and economical for main line traffic as well as for congested terminal zones. Even more significant than the data which they presented, however, were the announcements made by both Mr. Katé and Mr. Murray of liberal extension of electrified zones contemplated by each of their roads at an early date.

Mr. George Gibbs of the Pennsylvania presented interesting figures on the operation of the Long Island Railroad. The equipment has been in service for three years and now includes 152 miles of electrified main track. Cost of operation per car mile for last year was 24.2 cents. Cost of power at the locomotive was approximately 1 cent per kw. hr.

Mr. Gibbs also presented some interesting data on the first years' operation of the new Pennsylvania Terminal in New York. The electrified zone is about 9 miles long of which 6½ miles are level and the remaining 2½ miles are in tunnels and tunnel approaches in which some heavy grades are encountered.

The tunnel is much drier than was expected so that the factor of adhesion of the locomotive drivers on the rails is much better than was expetced. This makes it possible to pull heavier loads than the locomotives were originally designed for.

Electrification of Railways

E. O'BRIEN

The problem which confronts railway companies, and which is never capable of complete solution, is the provision of an economical, efficient and financially sound system of transport, which at the same time will be convenient for and popular with the traveling public. The business of the railway companies is to sell transport of both goods and passengers, and it matters little to the buyers what method of traction is employed to convey them or their goods, from one point to another, so long as it is done in a safe and expeditious manner.

schedule speed, so that the increased density of traffic has to be relied upon to make the more rapid transit a profitable undertaking. It follows therefore that it can only succeed in localities where passengers can be gathered in from slower systems of transit, or where there are districts to develop for residential or other purposes. This development incidentally brings with it not only an increase in passenger traffic, but also in goods.

As the maximum economical schedule speed with

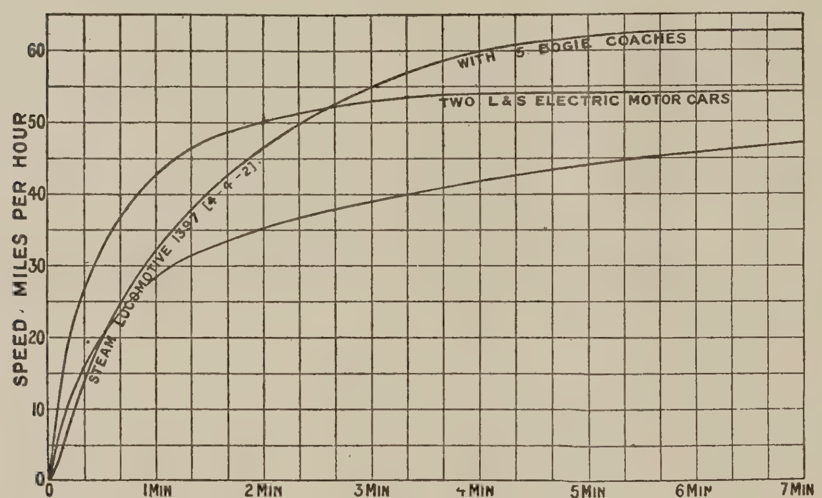


Fig. 1.

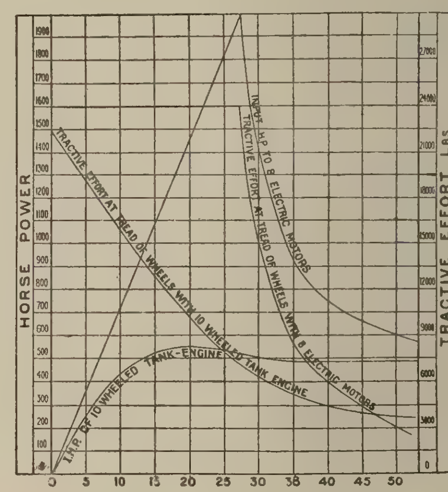


Fig. 2.

stations about 1¼ miles apart is nearly 30 miles per hour, on the assumption mentioned that one hour represents the maximum distance the business man will live from his work, the radius of economical and remunerative suburban tarffic may be placed at approximately 30 miles from any large town. Of course it will be understood that it would not be worth while to electrify many suburban lines for such a distance as this, owing to the intermediate stations being unsuitable for residential purposes, and also the business carried on at these stations not necessitating frequent connections with the urban centre.

Rapidity of transit is an all important consideration, and in the selection of a system this point must be kept well to the front, since the average traveling Briton would like every train to be an express, so far as his own particular journey is concerned. Of the traveling public, the most important section is formed of business men, and with them especially time is money. With the growth of manufacturing centres, and as a result, the driving further afield of desirable residential localities, more and more time per day must be given to traveling, and since it is impossible to provide every passenger with his express train, the system of traction which will give a high schedule speed where stops are frequent, is the one which will succeed. The distance that the business man can live from his business is therefore not to be reckoned in miles but in time, and the limit of this may be placed at one hour.

The conditions required for such a successful passenger service are fulfilled by electric traction. High acceleration and consequent high schedule speed can be obtained, increasing the radius of the residential area, and giving a service which is convenient to all those who dwell in this area. In any district where two different systems of transit are in use, the more rapid system will inevitably rob the slower system, suburban districts will be developed, and an increased density of traffic result. The cost of any system of transit increases very rapidly with small increases of

We may now proceed to consider the technical reasons for the economy of electric traction applied to suburban traffic, and the probability of its success in other fields such as main line express work and for goods trains.

Steam traction, for rapid suburban traffic, has reached its limit, any attempt to run an electric schedule with steam trains increases the cost, both of fuel and maintenance to a prohibitive point. For ease and flexibility it compares very unfavorably with electric traction, in fact many things can be done with the latter which are impossible with steam. An electric motor car will run 50,000 miles without visiting the shed other than for stabling, and can be kept in continuous service for 20 hours daily, the only attention required being brake adjustment. A steam locomotive on a similar service must obtain coal every 150 miles, and requires a thorough washing out and overhaul every 1,200 miles at the least. By reason of its higher acceleration and average speed on short runs,

*Read before the Manchester Association of Engineers by Mr. E. O'Brien, Horwich.

the electric service can be incr?ased in frequency with the same headway between trains, thus increasing the capacity of the line. This increase of capacity shows to the greatest advantage at terminal stations, where it is almost 100 per cent.

Instead of stand-by engines, and a dozen switching and signaling operations being required, during which two or more roads are blocked, and which cannot be completed under five minutes even with the most favorable conditions, the electric train is ready to depart as soon as the motor-man can walk from one end to the other. As an instance of the despatch which is possible may be cited the Aintree Race Traffic on the electrified portion of the Lancs and Yorks R. where an electric train discharges a thousand passengers, the time between arrival and departure being ninety seconds.

Fig. 1 gives the time speed curves of a multiple unit two-car electric train, a ten-wheeled express passenger engine with five coaches, and a ten-wheeled radial tank engine used for suburban traffic with seven coaches.

age speed approaching the maximum speed. Thus the train obtains its maximum speed very quickly, and the power may be shut off, and advantage taken of the good coasting qualities of electric stock, to run the greater part of the journey absorbing the energy stored in the train. For the same schedule, the lower the acceleration the longer the power must be kept on, which in turn lessens the time for coasting, the energy put into the train being almost wholly absorbed by the brakes. The effect of this is shown in Figs. 2 and 3, in which the curves A, B and C in each diagram indicate the time speed curves and power required for three different accelerations, particulars of which are given as under.

Curve.	A	B	C
Mean acceleration up to 25 miles per hour in M. P. H. per second.....	0 58	0 86	1 47
K. W. hrs. for one-mile run at schedule speed of 25 M. P. H.........	9 0	7 45	7 1
Watt-hours per ton-mile..........	63	52	49

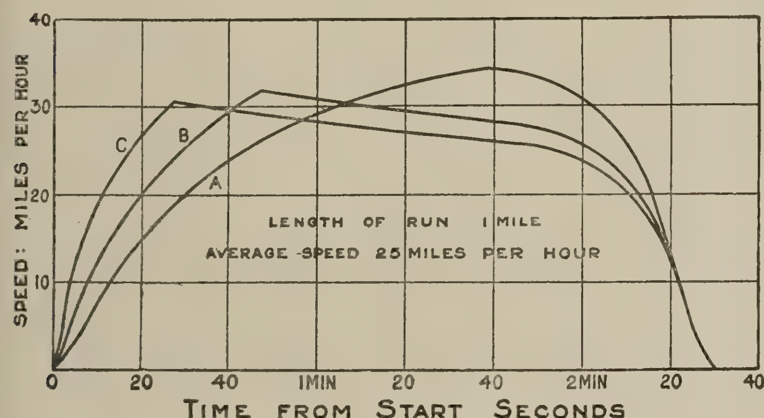


Fig. 3.

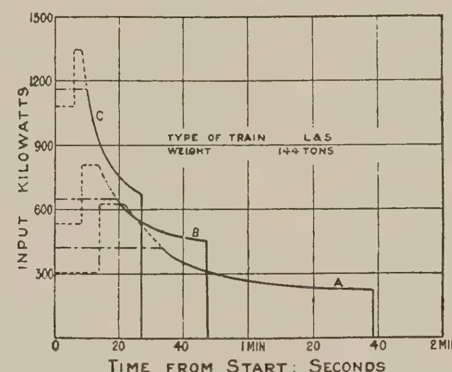


Fig. 4.

Though the test of the electric train was carried out with two cars only, the same acceleration can be obtained with any number of cars since each carries its own motors. Table I gives the particulars.

Table I. Steam Train.	Express Passenger.	Suburban Passenger.	Electric Train.
Total weight (taken the same in each case)..	205 tons	209 tons	205 tons
Number of Vehicles..........	5	7	4
Total seating capacity........	300	400	306
Weight required for propulsion	90 tons	77.5 tons	71.1 tons
Acc. up to 10 M.P.H. in M.P.H. per sec.	0.67	0.95	2.0
" " 20 " "	0.67	0.67	1.65
" " 30 " "	0.57	0.43	1.2
Maximum speed	65 M.P.H.	60 M.P.H.	54 M.P.H.

The reason for the higher acceleration is at once apparent from the curves in Fig. 1A, in which a steam and electric train of similar maximum tractive effort are compared. The tractive effort which can be applied to a train is limited by the slipping of the wheels, and an electric train with eight driving axles has a very considerable advantage over a steam train with only two. The maximum effort can be maintained up to 27 miles per hour with the electric drive, whereas the tractive effort with steam falls rapidly, and at 27 miles per hour is only one-third of the maximum.

The advantage of the higher acceleration gradually decreases with the length of the run, and in the case where the maximum speed of the steam train is greater than that of the electric it disappears altogether, i. e., the average speed is the same when the distance traversed is five miles.

Due to the ease with which high acceleration can be obtained, electric traction lends itself to the most economical running. High acceleration means high aver-

The length of run and time taken is the same in each case, and the train consists of four cars, total weight 144 tons.

The curve, Fig. 4, shows the decrease in energy consumption with increase of acceleration up to 2.3 feet per second.

It will be noticed that the speed during coasting decreases very slightly, and that the train is still traveling at a high speed when the brakes are applied. A considerable amount of energy is therefore absorbed by the brakes. Since all this energy must necessarily be imparted to the train during acceleration, and as the amount of energy is proportional to the weight of the train, it follows that this latter is a matter for serious consideration. The cars should be as light as possible, consistent with safety and comfort. The proof of this is shown in Figs. 5, 6 and 7. Comparisons of three trains are made, the first two actual sets running on the Liverpool and Southport electrified railway, and the third a hypothetical case for a much lighter train with the same seating capacity. The particulars are given below:

	(1) L. & S. Standard Cars	(2) L. & S. M. U. Small Type Cars	(3) 75-ton train
No. of Motor Cars..............	2	5	5
No. of Trailer Cars..............	2	0	0
Weight of Motor Cars...........	46 tons	22 tons	15 tons
Weight of Trailer Cars..........	26 tons	—	—
H. P. of motors................	8×150=1,200	10×125=1,50	—
Overall length of train.........	248 ft.	242 ft.	248 ft.
Weight of train.................	144 tons	110 tons	75 tons
Floor area per car.............	60 ft.×10 ft.	45 ft.×9 ft. 6 in.	—
Total area per train...........	2,400 sq. ft.	2,135 sq. ft.	2,400 sq. ft.
No. of seats (one per 10 sq. ft.)..	240	213	240
Seats per ton..................	1.66	1.94	3.2

The same acceleration and schedule has been taken for the three cases, and the energy consumption calculated for stops ½ to 6 miles apart. The speer curve gives the average speed for each distance, excluding stops. The earning capacity of the trains depends upon the energy consumption per passenger, or the watt-hours per seat-mile. Fig. 6 and Table II show very clearly the effect which the reduction of weight per seat has on the energy consumption.

TABLE II.

Energy Consumption Delivered to Train in Watt-Hours per Seat-Mile.

Run in Miles.	½	1	2	3	4	5	6
Average speed M. P. H.	22	29	36	40	42	43.5	44.5
144-ton train	61	51	41	36	33.5	32	31
Energy 110-ton train	52.5	45	36.5	33	31	30	29
Energy 75-ton train	32.5	27.5	23.5	22	21.5	21	20.5

It will be noticed that for short runs the energy is almost exactly proportional to the weight of the train, but that this is not so for longer runs. This is due to the energy on the shorter runs being almost entirely used in accelerating the train, whereas on the longer runs the effect of the train resistance predominates. The shorter the runs, therefore, the more important it is to keep the rolling stock as light as possible.

In electrifying the L. and S. Line it was necessary in the transition stage to run steam trains to nearly the same schedule as the electric; as a result it was found that the coal consumption of the slower steam trains was nearly double that of the electric train, the running wages were doubled, and though these steam trains were only run a few weeks the engines showed that the repair bill would have been enormous had the steam service been continued.

The electric service is a more flexible one, and by adding more motor-cars to a train, or trailers within the limits of the motors, the morning and evening fluctuations of the traffic can be easily met.

It is, therefore, clear that for suburban traffic, with short distances between the stations, electric traction shows very considerable economies over steam, and the earning capacity of the trains is much greater.

Before approaching the problem of electrifying main lines the advantages and disadvantages of the various systems of electric traction applied to suburban lines had better be considered.

Systems of Electric Traction.

The earlier systems of electric traction were, without exception, direct current. In recent years, however, alternating current traction, especially single phase, has made rapid progress. The systems are classified below.

Direct Current—

(1) Generated and distributed at the line voltage.

(2) Generated at high voltage alternating current and transformed down and converted to low tension direct current at substation.

(3) High-tension direct current.

Alternating Current—

(4) Single phase.

(5) Three phase.

Systems 2, 3 and 4 are diagramatically illustrated in Figs. 8, 9 and 10.

System (1) is in general use in the smaller light railway and tramway systems. The generators work at the line voltage, and are connected directly to the line by feeders. For outlying districts boosters are used to maintain the line voltage.

System (2) is in general use in the heavier railway systems. It combines the high efficiency and economy of generating and distributing at high voltage alternating, in nearly every case three-phase, and the simplicity of direct current traction. Substations are fixed as required along the line, and conversions made from high voltage alternating to low voltage direct by means of transformers and rotary converters or motor-generators. Progress has been made recently in System (3)—high tension direct current. The objection to this system, or, rather, the obstacle to progress hitherto has been commutator trouble with increase of voltage. This is being gradually overcome, and a system evolved which will combine the simplicity and economy of direct current motors with the economy of high tension transmission, which has previously been monopolized by alternating current systems, and this will be done withont any intermediate conversion.

In Systems (4) and (5), alternating current and simple, single-phase and multi-phase is used. Current is transmitted either direct to the cars at high voltage where it is transformed down, in the case of single-phase to a low voltage for the motors, or in the case of three-phase high voltage motors are used.

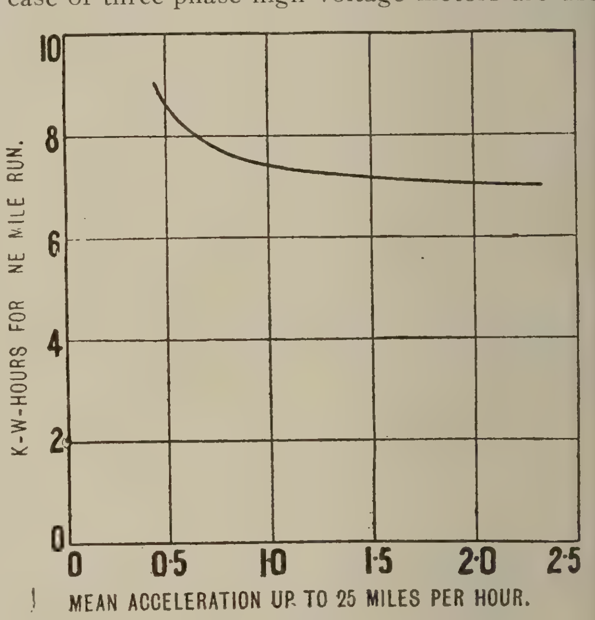


Fig. 5.

In long-distance transmission schemes the generators work at extra high voltage, and static transformer sub-stations are used to transform the power to line voltage.

The direct current being continuously in one direction may be compared to a steam turbine, the alternating single-phase finds an analogy in a single-cylinder reciprocating engine, and the three-phase in the three-cylinder engine.

Heavy electric traction is by no means an electrical engineering problem pure and simple. A special knowledge of the conditions which obtain on railways and which can only be acquired by actual experience in the traffic and locomotive departments, is essential for the solution of the problems involved. A lack of this knowledge on the part of electrical engineers has rendered progress in electrical traction slower than it would have been otherwise. It is not only the railway engineering side of the question which is neglected but also the financial side. This is detrimental to progress, for the railway official looks upon electric traction from a railway point of view, that is, the scheme must be firstly financially sound, then it must conform as closely as possible to railway conditions and lastly comes the electrical engineering part of the problem. The choice of a system then is one which must be considered on the lines just indicated

Advantages and Disadvantages of Three Systems.

	Direct Current.	Single-Phase.	Three-Phase.
Capital Cost.			
Electrical equipment on train	Lowest	Highest	Intermediate
Track equipment	Lowest	Cost more than D. C.	Highest, much more expensive at junctions
Sub-Stations	High	Much less than D. C. (if installed)	Same as S. P.
Feeder System	Low	High owing to low power factor and badly balanced 3-phase system	Rather lower than S. P. owing to balanced 3-phase system
Power Station	Low	High (reasons as above)	Low, but higher than D. C. (reasons as above)
Maintenance.			
Sub-Stations	Low	Low or Nil	Low or Nil
Remainder of System		About equal	
Efficiency.			
Locomotive or Motor Car equipment			
(a) Running.	Highest	Lowest	Intermediate
(b) Notching	Low and equal to 3-phase	Highest	Same as D. C.
Track equipment	Lowest	Higher than D. C.	
Sub-Stations	Lowest	Highest and equal	
Feeder system and Power Station		Equal	
Miscellaneous.			
Maximum number of running notches	Three	All	3 with much complication
Weight of Electric equipment	Intermediate	Highest	Lowest
Speed of Motor	Lowest	Highest	Intermediate
Commutator troubles	Lower than S.P.	Higher than D. C.	None
Track equipment in tunnels	Standard	Special involves heavy complications in many instances	
Interference with repairs to track	Slight	None	Slight
Interference with Signaling	None	Slight	Slight
Use of batteries as load equalizer	Available	Available with complications	Available with complications
Speed on up grade	Falls	Falls	Constant
Regeneration	Heavy complications	Heavy complications	Can be used without complications

It must be remembered that in the electrification of a steam railway the line already exists, with its junctions, crossings, bridges, sidings, and signals, and that the scheme must overcome all difficulties arising from these when constructing either third-rail or overhead equipment.

THE COMPENSATED AMPERE HOUR METER.

The Sangamo Electric Co. have just designed a new ampere hour meter which is of special interest to battery engineers. It is well known that if a battery be discharged at a high rate, the total ampere hour capacity available before the voltage falls below critical value will be reduced considerably, and this reducing effect varies directly with the increasing rate of discharge.

Where ampere hour meters have been used in vehicle service, and the vehicle run at excess of speed so that an abnormal rate of discharge is maintained, the ordinary ampere hour meter reading would indicate that considerable capacity was left in the battery, where, as a matter of fact, due to the high rate of discharge, the capacity of the battery was virtually gone. To overcome this objection this meter has been designed which runs faster on high rates of discharge than on low rates; in fact the speed of recording becomes a direct function of the speed of the car.

The meter contains an auxiliary magnetic circuit on which is placed a series winding so that the magnetic flux varies directly with the battery current, this causing the meter to speed up as desired. On discharging the auxiliary field will be reversed and oppose the main magnetic field of the meter. Accordingly, when the battery is both charged and discharged at a high rate it will always be underdischarged and to a certain degree overcharged at every cycle of the battery. This type of ampere hour meter then becomes a sort of a battery pressure guage instead of a true ampere hour meter.

NATIONAL RAILWAY APPLIANCE SHOW.

The annual show of the National Railway Appliance Association given in connection with the annual meeting of the American Railway Engineering Association at Chicago was a bigger success than ever before. This year the call for space was so great that it was necessary to use the First Regiment Armory as an overflow hall to accommodate some of the exhibits.

The following exhibits were of particular interest to electrical men:

The American Steel and Wire Company, a complete line of iron, steel bare and insulated copper wire, galvanized strand, re-enforcing mesh and steel bars, etc.

Edison Storage Battery Company exhibited both their railway signal and their car lighting batteries. Mounted on a large display board were dissected parts of the battery showing its internal construction, method of manufacture, etc.

Mr. H. G. Thompson, Manager of the Railway Dept., was in charge of the exhibit.

The Electric Storage Battery Company exhibited both their railway car lighting and signal cells and showed samples of the various types of plates manufactured by that Company.

The General Electrical Company had a large and very interesting exhibit of their power and signal equipment.

H. W. Johns-Manville Company showed in addition to their usual exhibit of asbestos smoke jacks, a complete line of fuses and cutouts, etc. Mr. J. E. Meek, Manager of Sales, was in charge of the exhibit.

The Kellogg-Switch Board and Supply Co. showed their standard equipment for telephone train dispatching. One of the interesting features of their exhibit was a new synchronous 4-party line selector using but one polarity. By reversing the polarity the number of stations which can be called may be doubled. This makes it possible for a dispatcher to call any one of 8 stations immediately without the use of any step-up device. The exhibit was in charge of Mr. Archibald Wray, Railway Telephone Engineer of the Kellogg Company.

Kerite Insulated and Wire Cable Company showed a complete line of Kerite wire for railway signalling and car lighting work. Raw Para rubber biscuits used in making Kerite were displayed. Major Azel Ames was in charge of the exhibit.

Okonite Company showed samples of Okonite wire for railway signalling and car lighting use, and the superior qualities of the Okonite tape were demonstrated. Mr. L. G. Martin of New York was in charge of the exhibit, and Mr. J. M. Lorenz, "Okonite Jim," was right on the job.

The Sandwich Electric Company showed their selectors for railway train dispatching.

The U. S. Electric Co., showed a complete exhibit of telephone train dispatching apparatus using Gill selectors and Kellogg telephones.

The U. S. Light and Heating Company exhibited their car lighting and signal batteries. Mr. W. P. Hawley of New York was in charge of the booth.

The Western Electric Company showed a complete line of their railway equipment including telephone train dispatching apparatus, flame lamps, telephones and general electrical accessories. Geo. H. Porter was in charge of the exhibit.

SHOP SECTION
EDITED BY
GEO. W. CRAVENS

Shop Series No. 11.

Springfield Shops of the Frisco System.

The car and locomotive shops of the St. Louis & San Francisco R. R. at Springfield, Mo., offer one of the best examples of "looking ahead" that may be found in this country. The problem put up to the engineers, The Arnold Co., of Chicago, was to so lay out the shops as to provide for 100 per cent extension, and then double the new total by the consolidation of two old shops with the new ones. And this had to be done in such a way as to provide for economical and rapid handling of any and all work coming to the shops, both before and after the ultimate extensions. As to how well this was carried out may easily be seen by the results.

Fig. 1. General View of Frisco Shops at Springfield, Mo.

The secret of this successful layout is in having those buildings which are common to all departments located in the center of the plant. These are the power house, store house and blacksmith shop. The office is also located here in a part of the store house. The power house is at the center of gravity of the load, near the machine and erecting shop, boiler and tank shop and the future planing mill. The store house is near the locomotive department, round houses, future freight car department and the transfer table and yard crane way. The blacksmith shop is close to the machine and erecting shop, round houses, scrap bins and yard crane.

A general survey of the arrangements shows the economy of the layout. The present machine and erecting shop and the boiler and tank shop are served by the transfer table that also serves the coach department. The coach repair shop is close to the coach paint shop and not far from the locomotive department. The future freight car department is grouped so the freight car repair shop and new freight car shop are both convenient to the planing mill and lumber yard. The arrangement is such that material may enter from one end, pass through the dry kiln, dry lumber storage, planing mill, new freight car shop and freight car paint shop in a continuous forward movement.

It will also be noted that the future steel car shop is adjacent to the new freight car shop and close to the present boiler and tank shop. This brings similar classes of work together, and the space between the buildings serves as a material yard for both of them. The steel cars will pass directly through the new freight car paint shop on their way out.

The future car wheel shop will be convenient to both freight car and coach shops on account of the transfer table and industrial tracks and the future pattern shop will be close to the foundry, planing mill and lumber yard. Provision is also made for a future crane between the foundry and store house platform, making the handling of foundry supplies and castings easy. The future oil house will be near the store house and round houses and not far from other departments using it.

The present capacity of the locomotive department is 35 to 40 engines per month, and of the coach department 35 coaches per month. These two departments will normally employ about 900 men when busy. All of the buildings are fireproof, being of brick, steel and concrete, the only wood being the floors, roof sheathing and window and door casings. Even the store house, platform, oil tanks, pump houses and power house roof and floor are of re-inforced concrete.

The buildings are unusually well lighted, one sq. foot of window area being provided for each 3 sq. ft. of floor area. Saw tooth roofs are used on the coach shops and large monitors on the machine, boiler, blacksmith and power houses.

Power Plant and Distribution System.

Three phase, 60 cycle, alternating current at 440 volts is used for all lighting and for all constant speed motors in these shops. The variable speed motors for machine tools, electric cranes and transfer tables are all operated by direct current from a 220 volt 300 k. w. rotary converter in the power house. The feeders for the new shops leave the new power house in underground conduits, from which some come overhead along the yard craneway girders and some continue underground direct to the panels at distribution centers. All of these panels are in steel cabinets with locks.

Plug receptacles of heavy construction are provided at frequent intervals along walls and columns for portable tools, lights, etc. The alternating current motors are all for 440 volt 3-phase operation and drive groups of tools, such as punches, shears, grinders, presses, etc., which require constant speed motors. Tools requiring variable speeds through a wide range, such as heavy lathes, boring mills, radial drills, millers, shapers, etc., are driven by continuous current, 220 volt motors with speed variations of 2 to 1, 3 to 1 or 4 to 1, as required. The direct current motors have drum controllers and circuit breakers, while the alternating current motors are equipped with auto-starters.

Controlling apparatus is provided for operating the power plants at the old and new shops together or separately, and power to a total of 450 k. w. may be supplied by either plant to the other one. There are three 150 k. w. transformers in each power house which step up the current from 440 volts to 6,600 volts for transmission to the other power house, where it is again stepped down to 440 volts for use. All lighting circuits operate on 220 volts, a balancing induction coil being located at each center of distribution and connected to the 440 volt mains in such a way as to produce a 3-wire, 220/440 volt system. The distribution centers are balanced on the three phases in such a way as to load the mains uniformly.

The new power house provides all of the power for the new shops, and 450 k. w. for the old shops as well. The building is 118 ft. by 145 ft. and fireproof throughout. It now contains boilers totalling 2,000 H. P. with space for 1,200 more, and provision is made for further extension if required. It is divided into three main sections by brick fire walls ,one for the turbines and generators, one for pumps and piping and one for the boilers. The chimney is 205 ft. high, 10 ft. diameter, and equipped with lightning rods. It is of reinforced concrete, as are also the smoke flues.

There are five 400 H. P. Babcock and Wilcox water tube boilers with space for three more, all equipped with superheaters and stokers. They carry a steam pressure of 150 lbs., the superheaters raising it to 250 lbs. By means of the narrow gauge tracks, turn tables, electric elevator and manually-operated bottom dumping coal and ash cars the handling of materials has been made very economical. The main bunkers have a capacity of 350 tons and are of steel and concrete. They hang from their supports like large parabolic pockets and coal flows from them easily by gravity. Emergency coal pockets of 400 tons capacity are also provided beneath the bunkers, but these are used for storing other materials just at present.

Fig. 1—A. General View of Frisco Shops at Springfield, Mo.

Located between the boiler and turbine rooms is the pump and piping room. Installed here are a 2,000 H. P. Webster open type feed water heater, two American Steam Pump Co.'s boiler feed pumps of 2,000 boiler H. P. each and two large vacuum pumps which return the water of condensation from the heating system to the feed water heater, thus saving it. Cooling water for the condensing equipment is supplied by two engine driven centrifugal circulating pumps of 2,440 gals. per minute. Two compound fire and service pumps, each of 1000 gals. per minute capacity, provide the general water supply at 65 lbs. pressure, and in case of fire will supply water at 100 lbs. pressure. Practically all of the steam, exhaust and water piping for the plant are in this room.

There are two 500 k. w. Westinghouse 3-phase, 60 cycle, 480 volt turbo-generators operating at a speed of 3600 R. P. M. now installed in the turbine room, and space for another 500 k. w. set and a 1000 k. w. set is provided. There are also a 300 k. w. rotary converter, a 30 k. w. engine driven exciter, a 30 k. w. motor driven exciter, three 150 k. w. transformers, a 2000 cu. ft. Laidlaw-Dunn-Gordon compound, two-stage air compressor and a switchboard of 13 panels in this room. Space is also provided for another 2000 cu. ft. air compressor. A barometric condenser, giving a vacuum of 28 inches, is

provided for each turbine and compressor. All auxiliary apparatus, piping, wiring and oiling system for the apparatus here is located in the basement.

All buildings requiring steam are supplied from this power plant with dry steam at 100 lbs. pressure through a regulating valve. This includes the steam hammers in the blacksmith shop, the testing lines in the locomotive erecting and boiler shops, the glue room in the cabinet shop, the brass cleaning rooms in the coach painting shop, and for the engines which drive the fans for the heating and ventilating system. During the winter all exhaust steam from the various parts of the shop is sent into the heating system, and by means of special apparatus all back pressure is kept from the turbines. The steam pipes are all carried underground in tunnels and are well insulated.

Locomotive Shop.

The machine and erecting shop of the locomotive department is the largest one here, as in most shops, and is 173 ft. wide by 566 ft. long. It covers nearly three acres and is divided into three bays or sections. The erecting bay is 65 ft. wide and contains 25 concrete engine-pits, each 45 ft. long, located on 22 ft. centers. Along one side and over the machinery bay is a gallery 40 ft. wide, which also contains light machinery.

In the erecting bay is a crane runway, mounted on the steel framework of the building, containing a 100-ton electric crane with two trolleys for locomotive hoisting and a 15-ton high speed crane for lighter work. The span is 61 ft. 3 inches. Mounted on the 100-ton crane is an auxiliary 10-ton hoist, and space is provided at one end of the building to allow the 15-ton crane to move beyond the last pit so the large crane may serve all pits.

Heavy steel-topped benches and steel racks for storage of locomotive parts are placed between the pits throughout the erecting bay, and steel compartments with locks are built into each steel column of this part of the buildings for storing heavy tools. Electric grinders are also placed at frequent intervals for use by the erecting gang. There is also a large lye vat and washing pit in this shop for dipping complete engine trucks to remove grease and dirt.

Along the edge of the erecting bay, on the side nearest the gallery, are located many large machine tools, each driven by one or more electric motors, for work on cylinders, frames, wheels, boxes and other heavy parts. All of these tools are served by electric cranes. Just back of the heavy tools, and below the gallery, are the lighter machine tools for work on pistons, valve gear, rods, etc. These are most of them driven in groups from line shafts. Each section of the line-shafting is driven by a separate motor, but couplings are provided for connecting two or more sections together in case of a motor failure. The tool room is located near the center of this section and contains much fine tool making machinery and steel racks and shelving for tool storage.

On the reinforced concrete balcony are the tin and copper shops, pipe shop, air brake, injector, headlight and boiler lagging departments, and the electrical shop. The floor of the balcony extends 7 feet beyond the steel columns out under the crane way to allow materials to be placed easily at any point in the length of the gallery. The large amount of machinery here is electrically driven, either singly or in groups, and benches extend the full length of the wall. The large fans for the heating system are also here. The artificial lighting here is by means of mercury vapor lamps, and all of the power and light mains are under ground.

Fig. 2. Day View of Locomotive Machine Shop.

The machine tools in this building are given on page 266-267.

Boiler and Tank Shop.

Just across the transfer table from the locomotive shop is the boiler and tank shop, the building being 118 ft. wide by 347 ft. long. This shop is divided into two main sections by a row of steel columns, one section 65 ft. wide containing 14 tracks on 20 ft. centers for assembling boilers and tanks, and the other section containing the machine tools. At one end of the building a space of 60 ft. is walled off for the locomotive carpenter shop. In this room all work is done on pilots, cabs, frames, etc. On one side are the electrically driven wood working machines and the other side is devoted to assembling and floor work.

Over the tracks in the assembling bay is a double trolley 30-ton crane, and a rivetting tower is located at one end of this bay with provision for the very heaviest class of work. The machinery in the other bay is nearly all arranged for individual electric motor drive, only the smaller tools being driven in groups. This section contains powerful tools for forming and finishing boilers and tanks, among them being bending rolls, shears, drills, punches and annealing furnaces, one of the latter being large enough to take plates up to 12 ft. square.

The large fan for the heating system is located near the center of the shop, and the building is piped for water, compressed air, steam for testing, fuel oil, air blast for furnaces and for heating. The natural lighting is very good and artificial light is provided by mercury vapor lamps. Receptacles are also provided at numerous places for portable carbon lamps on leaders. The machine tools with motor sizes in this building are given on page 267.

Coach Repair and Paint Shops.

The building containing the coach repair shop is 304 ft. long by 209 ft. wide and contains 22 stalls for coach repairs, in addition to the cabinet shop and upholstery department, which are located in the east end of the building near the foreman's office.

This shop is arranged with a 10-ton crane way down the center of the building, and the tracks take two coaches each, one each side of the crane way. Under the crane is space for trucks to be placed for repairs. A feature of this building is the system of permanent, adjustable steel scaffolds which may be arranged at any height or distance from the coaches, and pushed up out of the way when not in use.

All of the machinery in the coach, cabinet and upholstery shops is driven by electric motors, individual drive being used for all but those in the cabinet shop. The lighting is by incandescent lamps, excepting the truck bay and cabinet shop, where mercury vapor lamps are used.

The coach paint shop is just across the transfer table from the repair shop and is 183 ft. by 184 ft. in size and contains 16 stalls. Each stall is provided with a concrete pit 81 ft. long and 8 inches deep which contains heating pipes. Rooms are cut off by fire walls for paint mixing, brass cleaning, plating and polishing. Counterweighted, adjustable steel shelving similar to that in the coach repair shop is provided here.

Saw-tooth roof construction is used over the entire building, thus providing uniform lighting of excellent quality. Incandescent lamps with long cards are located between the tracks for interior work on coaches. Electric motors drive the brass working machinery, and compressed air pipes for paint burners, hose valves for water service and steam heating pipes are carried throughout the building.

Blacksmith Shop.

This shop lies east of the locomotive machine shop and is 102 feet wide by 245 feet long, roof trusses spanning full width and no columns in the building. The storage compartments for iron, coal, tools, etc., are located just north of this forge shop and occupy a space 30 feet by 150 feet.

Provision is made to have material enter the shop from the north, pass through the various stages to completion and leave the west end of the building for the other shops or store house. Mercury vapor lamps are used all through this shop, and smoke and gases are minimized by hoods over the fires and forges with stacks up through the roof. The floor is of cinders packed as hard and smooth as asphalt.

Fig. 3. View of Locomotive Machine Shop at Night.

All machinery except the steam hammers is operated by electric motors. The equipment is modern and well grouped, and consists of forges, furnaces, punches, shears, bolt and nut machinery, jib cranes, hammers, tools and the other things usually found in well equipped shops. Piping is installed throughout the building for steam, water, fuel oil, heating, compressed air and air blast for the furnaces and forges. Two large electric motor driven Sturtevant 10-oz. pressure blowers supply the blast system, these blowers being so connected that they may be operated singly or together.

Store House and Office.

Located in the exact center of the plant is a two story building 61 ft. wide by 162 ft. long containing the works offices and the main store rooms. A 15 ft. platform runs along each side of the building and extends 248 ft. beyond one end with a width of 90 ft. The floor is 4 ft. above grade and level with car floors.

The first floor contains the general storekeeper's office and the general timekeeper's office in addition to sections for storage. Steel shelving and hacks of special design to suit the various materials stored are used throughout, and all stock is arranged according to the Frisco Standard classification.

The second story also contains offices and storage rooms, the offices being in the west end of the building where they command a good view of the entire plant. The offices include the superintendent's, conference room, general office for clerks, drafting and blue print rooms, apprentices class room and toilets.

The building is made of reinforced concrete with no wood except in windows and for office trim, and fire hose is placed at frequent intervals. The stock of oil is in concrete tanks outside of the building, with pumps in a separate room for drawing it off. Two large doors on the second floor open out onto bracketed platforms for receiving freight by means of the yard cranes.

Yards and Cranes.

The arrangement of locomotive and coach shops is such that one transfer table can serve them, and an 80 ft. table is provided. It has a capacity of 180 tons and runs at a speed of 300 ft. perminute. The pit contains 5 rails and is 1,338 ft. long. Two electric motors drive the table with current supplied by two third rails. These two rails are at each side of the pit and are set back under a concrete ledge for safety.

At intervals of 100 ft. there are walks 5 ft. wide crossing the pit at rail level with inclines each side, and the third rails are sectionalized at these points with cables connecting them through conduits. A contact shoe is placed at each end of the table so the gap in the rail may be spanned and a continuous supply of current provided. This was the first installation of its kind and has been copied several times since.

In order that material may be easily placed on the transfer table by the yard crane, the runway extends 25 ft. under the crane way at the east end. This makes the crane and table of great importance for handling material. The yard crane runway is of steel, 800 ft. long, and extends north and south at right angles to the transfer table. The rails are 23 ft. above grade and the span is 75 ft. The crane is rated at 10 tons but will carry 12½ tons, and has a travelling speed of 450 ft. per minute with a hoisting speed of 60 ft. per minute. The storehouse platform also extends 25 ft. under the craneway, thus facilitating the handling of material and making the crane a connecting link between all parts of the yards.

In addition to the above is a standard gauge industrial track system connecting all departments and plentifully supplied with turntables. This is additional to and independent of the crane and transfer table.

Miscellaneous.

In general, this is one of the best equipped and arranged railroad shops in the United States today, and it will be interesting to follow its expansion to see how far it has been possible to accurately predetermine developments, as has been attempted in this instance.

As an additional illustration of the care with which everything has been considered, the water supply is a good example. Two sources of supply are provided and arrangements made for a third one. There are now three 8¼-inch wells 900 ft. deep, delivering 150 gallons per minute by motor driven pumps to a cistern in the pump room of the power house. There is also a 15 acre pond in the yards with a capacity of 20 millions of gallons. Over 200 acres of ground and roofs drain into this pond and an 18-inch pipe line drains the water into another cistern in the power house.

A separate underground distribution system is provided for drinking water and for the lavatories, the supply coming from three deep wells. Condensing water is taken from the pond, and the water from the hot wells of the condenser flows back to the pond through the storm sewers and is again cooled for use.

The pumps are so cross-connected and provided with valves that service may be interchanged on the circulating, general service and drinking water pumps in case of emergency. In case of fire water may be drawn from the pond or from a 100,000 gallon elevated tank. There are 25 hydrants throughout the grounds and 97 hose valves inside buildings.

The buildings are heated by means of an exhaust steam vacuum system, the steam being carried through a pipe line in a tunnel 7 ft. wide by 5 ft. high, which connects all of the buildings and also contains pipes for high pressure steam, compressed air and condensed water returns. A combined hot blast and direct radiation system is used in the machine and erecting shop ,the coach shops, blacksmith shop and storehouse being heated by direct radiation only. The Van Auken vacuum system is used and it keeps the pressure down so as to prevent back pressure on the power plant units.

Fig. 4. Interior of Power Plant.

The steam hammers, locomotive and boiler testing lines, glue-rooms, brass cleaning rooms and blast fan engines are supplied with dry steam at 100 lbs. pressure through a regulating valve. Compressed air is supplied at 100 lbs. by the 2000 cu. ft. compound compressor in the power house. It is cooled in 2 large steel reservoirs outside the power house and distributed underground to the numerous outlets throughout the shops for drills, reamers, caulkers, expenders, etc., etc.

Underground concrete storage tanks with a total capacity of 40,000 gallons are provided for fuel oil. From these the oil flows by gravity to an auxiliary tank and thence by electric motor driven pumps into an overhead tank in the blacksmith shop, from which the oil flows by gravity to all furnaces in the blacksmith and boiler shops. The electric pumps are automatically governed to keep the oil level up to a pre-determined minimum, and the supply line is metered.

The central telephone exchange in the office building controls 14 local stations in the shops and at the two old plants. The Gamewell fire alarm system has 12 stations, all boxes being in the outside of the buildings and so placed that one may be reached from any part of the shops by going about 200 ft. The alarm apparatus consists of a gong, whistle trip and recording device, all electrically operated.

The author wishes to express his appreciation of the co-operation given him by Mr. P. L. Battey, of the Arnold Co., Engineers, in preparing the matter for this article.

TOOLS IN LOCOMOTIVE MACHINE SHOP.

Motor Driven.

Cylinder Boring Machine	10-H. P.-D. C.
1—84 in. driving wheel lathes	25-H. P.-D. C.
1—84 in. driving wheel lathe, high speed tools	50-H. P.-D. C.
1—85 in. quartering machine	3-H. P.-D. C.
1—Axle lathe	10-H. P.-D. C.
1—42 in. car wheel borer	12½-H. P.-D. C.
1—100 in. 400 ton hydraulic wheel press	15-H. P.

1—50 in. 300 ton hydraulic wheel press............10-H. P.
1—Car wheel lathe ....27½-H. P.-D. C.
1—28 in. engine lathe ....10-H. P.-D. C.
1—36 in. engine lathe ....10-H. P.-D. C.
1—Axle lathe ....10-H. P.-A. C.
1—Turret screw machine ....
1—Forming lathe. ....
1—Planer ....15-H. P.-A. C.
1—6¼x26 in. turret lathe ....
1—86 in. boring and turning mill. ....
1—54 in. boring mill ....10-H. P.-A. C.
1—42 in. boring mill ....10-H. P.-A. C.
1—30 in. boring mill ....10-H. P.-A. 2
1—72x72 in. planer ....35-H. P.-A. C.
1—42x42 in. planers ....15-H. P.-A. C.
1—42x42 in. planer ....15-H. P.-A. C.
1—36 in. double horizontal mill mill ....10-H. P.-D. C.
1—10 in. slotting machine ....3-H. P.-D. C.
1—13¼ in. heavy slotting machine ....7½-H. P.-D. C
1—6½ ft. radial drill ....5-H. P.-D. C.
1—29 in. double horizontal milling machine..20-H. P.-D. C.
1—5½ ft. radical drill ....5-H. P.
1—Punch and shear (25 in throt) ....15-H. P.-A. C.
3—32 in. vertical drills, each..................2-H. P.-A. C.
1—Horizontal boring and drilling machine..7½-H. P.-D. C.

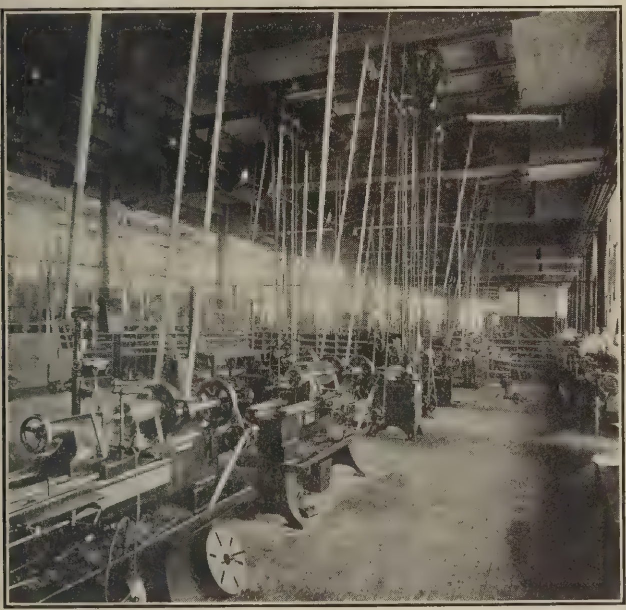


Fig. 5. Tool Room.

Group Driven.

3—16 in. bolt lathes.
4—16 in. bolt and screw cutting lahets.
4—18 in. engine lathes.
4—20 in. engine lathes.
4—24 in. engine lathes.
1—28 in. engine lathes.
1—36 in. engine lathes.
2—36 in. vertical turret lathes.
1—24 in. cabinet turret brass lathe.
2—20 in. cabinet turret brass lathes.
1—21 x 3½ in. turret lathe.
1—2½ in. cock grinder.
1—2 spindle valve milling machine.
2—36x36 in. planers.
1—20x20x24 in. crank planer.
1—26 in. head shaping machine.
1—4½ ft. radial drill.
1—36 in. high duty drill.
2—15 in. sensitive drills with column.
2—4 spindle drills.
3—2 spindle centering machines.
1—Pipe machine.
2—Triple bolt cutters.

TOOL ROOM TOOLS.

Motor Driven.

1—100 ton hydraulic forcing press.
6—Double emery wheel grinders.
2—Spiral disc grinders.

Group Driven.

1—14 in. engine lathe.
1—14 in. shaping machine.
1—Hand milling machine.
1—Drilling and milling machine.
1—20 in. vertical drill.
1—Universal milling machine.
1—15x30 in. shaper.
1—24 in. tool grinder.
1—Automatic tool grinder.
1—No. 1 Universal tool grinder.
1—Die grinder for bolt dies.
1—Disc grinder.
1—3½ in. twist drill grinder.
2—Pipe bending machines.
2—30 ton arbor presses.
2—26 in. rotary valve seat planers.
2—Link grinders.
3—Double spindle floor grinders.
3—8x60 in. grindstones.
1—18x72 in. planer surfacer.

BOILER SHOP TOOLS.

Motor Driven.

1—Large binding rolls ....10-H.P.-A. C.
1—Punch ....7½-H. P.-A. C.
1—Flue Cleaner ....15-H. P.-A. C.
1—Horizontal punch ....7½-H. P. A. C.
1—66 in. plain radial drill ....5-H. P.-D. C.
1—32 in. vertical drill.
1—Grinder ....½-H. P.-A. C.

Group Driven...

2—Rotary shears.
2—Single punches.
1—Angle shears.
2—Flue welders.
1—Single emery wheel grinders.
3—Pressure blowers.
2—Wheel grinders.
2—2x60 in. grindstones.

BLACKSMITH SHOP TOOLS.

Motor Driven.

1—25 in. punch and shear.
1—16 in. open bar shear.

Miscellaneous.

6—Steam Hammers, 150 lbs. to 3000 lbs.

Group Driven.

1—2 in. forging machine.
1—Combined punch and shear.
1—Hammer bolt header.
2—Bending machines.
1—3½ in. single head bolt cutter.
1—4 spindle geared nut tapper.
1—32 in. upright drill.
2—26 in. upright drill.
1—2 in. double head bolt cutter.

CAR SHOP TOOLS.

Group Driven.

2—Universal wood workers.
2—Scroll saws.
1—36 in. vertical cut off saw.
1—Tenoning machine.
1—Automatic knife grinder.
1—Saw bench triple arbor.
1—Heavy vertical mortiser.
1—Mortiser and boring machine.
1—30 in. double surfacer.
1—Edge moulding machine.
1—Band saw.
1—Triple arbor saw bench.
1—30 in. lathe.
1—Spiral disc grinder.
1—Automatic hollow chisel mortiser.
1—Power and hand pipe machine.
1—Foot power miterer.

H. W. JOHNS-MANVILLE NEW FACTORY.

H. W. Johns-Manville Co. has recently purchased a large tract of over 200 acres of Finderne, N. J., where it will erect a general Eastern factory. The output of this factory will be sufficient to meet the entire demand of their produce in the Eastern section of the country.

The company will very shortly move its executive offices from 100 Williams St., New York, to its new building at Madison Ave. & 41st St., New York.

A. B. C. CAR LIGHTING SERIES
EDITED BY
EDWARD WRAY

Lesson No. III.

The Lead Storage Battery.

Did you ever look at a storage battery faithfully lighting a car or a whole train for hours, supplying energy stored up within itself in some peculiar manner, and wonder "How," and, "Why?" For more than a century the best scientists in the world have been asking themselves these same questions, but like everything else in electricity—when it comes down to bed-rock explanation—nobody knows.

There are, however, a few basic facts which help to explain it—things, which we know from experience will always happen. When we drop an object we know it will fall to the earth but how or why we can't explain. We know from experience that *if we place any two unlike metals in an acid solution there will be an electromotive force developed* which, if wires are run from one plate to the other, will cause an electric current to flow. With certain metals such as gold and silver plates in acid solution, there will be a very weak voltage developed while with other combinations such as copper and zinc (the battery used for telegraph circuits) or zinc and carbon (the ordinary dry cell) more than one volt per cell may be generated.

In these batteries the zinc plate is eaten away as the current flows and must be replaced with a new one when used up. All batteries such as the above in which one plate is eaten away as discharge current flows and cannot be restored by forcing the current to flow in the reverse direction as on charge, are called "Primary Batteries." The other class, the "Secondary" or "Storage Batteries," are those in which the action is reversible—certain changes occur on discharge but by forcing the current to flow in the reverse direction as on charge the plates may be restored to their original condition. The ordinary lead cell and the nickel-iron cell are examples of this type. These are two big important subjects each worthy of special consideration, so we will take up only the theory and operation of the lead cell in April and May, the construction of various types of lead cells in June, and the construction and operation of the nickel iron cell in July.

Chemical Action.

Most books on storage battery start out with a long discussion about ions, chemical equations, etc., but we want to make these car lighting lessons as simple and practical as possible so we will omit all of the technical side of the storage battery and confine ourselves only to the practical side.

There are two well established facts which help wonderfully in understanding the action of a storage battery.

1. The first is as stated above that *any two unlike metals* (or plates of metalic oxides) *when placed in an electrolyte will generate a certain electro motive force or voltage*, this depending upon the metals selected and also upon the kind of electrolyte used.

2. The second is, that *when an electric current passes through a solution, certain chemical changes will take place at each of the plates* where the current enters and leaves the solution. These chemical changes occur whether the current is flowing in a charge or discharge direction, but are of a reverse nature.

THE PLATES.

The plates in a lead storage battery consist normally of peroxide of lead in the positive and lead sponge in the negative and sulphuric acid electrolyte. These plates, being of unlike materials, as per fact No. 1, will generate an electro motive force, and as the current flows through that battery on discharge, certain chemical changes will occur at the plates as per fact No. 2. The result is, that the active material in both plates (sponge lead and lead peroxide) will be changed to lead sulphate on discharge, the sulphuric acid required for the formation of the sulphate being taken from the electrolyte. A small amount of water is also formed in this chemical change, and as sulphuric acid is taken out of the electrolyte on discharge, it will cause the density or "gravity" of the electrolyte to diminish materially. On charge the current will be forced in the reverse direction through the battery and the chemical action in the plates will be reversed. That is, the lead sulphate formed on discharge will be broken up and the sulphuric acid will be driven out of the plates into the electrolyte. The result is, that gravity of the acid will increase on charge.

There are three distinct types of plates used in connection with storage batteries.

(A.) **Pasted Plate**, in which the plate if formed by pasting a mixture of red lead and litharge into a cast antimony lead grid. These are then dried and placed into tanks where they are charged and discharged a few times until all the red lead and litharge is converted into lead peroxide in the positive plates and spongy lead in the negative plates.

(B.) **The Plante Type.** These plates are made from rolled sheet lead which is worked up by various methods to thin laminations or leaves giving the plate a large surface of lead exposed to the acid action. These lead plates are then placed, as positives, into a forming solution which attacks the lead and an electric current is forced through. With the combined action of the electric current and the strong forming solution, the surface of the lead making up the many laminations is attacked and converted into lead peroxide. The depth of the active material formed depends upon the degree to which this forming action has been carried out. The plates to be used as negatives are then connected up, as negatives, with positives and charging current forced through. The result is that the peroxide in the negatives is reduced to lead sponge.

(C.) **Initially Formed Plates** in which the spongy lead for the negatives and the peroxide of lead for the positives and the peroxide of lead fthardodhhrhrdrduu positives are both formed electrolytically in tanks and then pressed into plates being formed into antimony lead grids under hydraulic pressure.

TEMPERATURE.

Temperature has a marked effect on the operation of a battery, for heat hastens chemical action and cold temperature (lack of heat) retards it. It should be remembered that in charging and discharging a battery, a chemical action takes place.

In a warm battery the acid electrolyte is more active and both goes into and leaves the plates more readily than it does at low temperature. If the temperature is too high however, the acid will be too active and will attack the plates forming permanent white sulphate which injures the plates. Battery temperature should never be allowed to go above 110° F. *This is the danger point.* In cold weather when the battery is some times operated at low temperature it will be found that it does not have as much capacity as when at normal temperature. This is due to the activity of the acid being much less at low temperatures. On intermittent discharge this reduction in capacity will be very much less than as a continuous discharge. Fig 15 shows the influence of temperature on battery capacity.

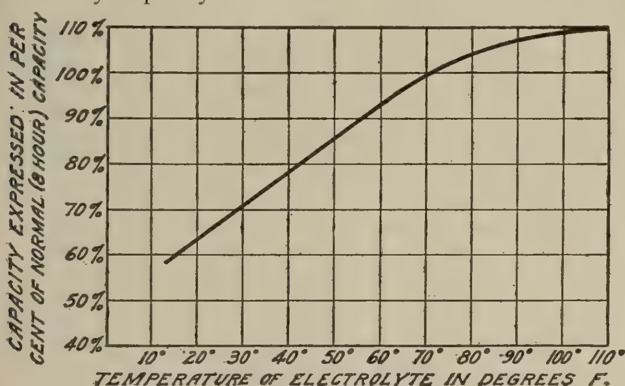


Fig. 15. Curve Showing Variation in Battery Capacity with Temperature.

ELECTROLYTE.

The electrolyte used in lead batteries is a mixture of sulphuric acid and water. Great care must be taken to always use absolutely pure acid and pure water (preferably distilled water). If any iron or copper gets into the acid even in the slightest degree, such as would be caused by a few flakes of iron rust falling into a carboy of acid, it will damage the battery to which that acid is applied.

In mixing strong acid and water, *pour the acid into the water, never the water into the acid.* Violent spitting of the acid which may result in the loss of eye sight will occur if this caution is not observed. Even when the acid is poured into the water this must be done with great care. The solution should be stirred thoroughly with a wooden spoon and allowed to cool before observing gravity reading. *Never use an iron or granite spoon for stirring.* The specific gravity of the electrolyte when placed in a new battery or one that has been overcharged and then cleaned should be between 1.215 and 1.225 at normal temperature (70° F.).

The following table gives the proper specific gravity of the electrolyte for various temperatures, the readings in all cases being that of the electrolyte at end of charge:

Degree Fahr.	Specific Gravity.
106	1208
97	1211
88	1214
79	1217
70 Normal	1220 Normal
61	1223
52	1226
43	1229
34	1232
25	1235
16	1238
7	1241

It will be noted that the correction is approximately 1 point for each 3° F. difference from normal temperature which is taken as 70° F.

Warm electrolyte should never be used in a cell as it accelerates the injurious effects produced by other causes, and shortens the life of the plates.

In diluting, if the concentrated acid is of a specific gravity 1.835 it will require four (4) carboys of pure water to one (1) carboy of acid to give an electrolyte of 1.200 gravity.

In battery operation there is a loss of water from the electrolyte due to gasing and evaporation. This should be replaced by pure or distilled water only; ***never by more acid or more electrolyte.*** Water is the only thing that has been given off in gasing in a closed cell, hence water is the only thing that should be used for flushing cells.

Loss of Gravity.

If you find that at the end of charging that the electrolyte does not come up to normal gravity, 1.215 or 1.225 degrees, you will usually find that sulphation of the active material either in the sediment in the bottom of the cell or in the plates themselves has occurred. Careful attention should be given this battery and either cleaning or treatment for sulphated plates may be necessary.

Normally the electrolyte should cover the top of the plates about 1¼ inch and it should never be allowed to get so low as to expose the top of the plates to the air. Rapid sulphation will occur on exposed parts. If it is found that cells require filling, or "flushing," more than once a month this is a sure indication of excessive overcharging and should be looked into at once.

OPERATION.

The one big thing in this lesson is that *the storage battery must be looked after very carefully.* If neglected, either deliberately or through lack of knowledge, nothing but disaster can result. A single act of carelessness on your part may cause hundreds of dollars worth of damage to the equipment.

In this course we can give only such general instructions as apply to all lead batteries. As the various types of lead batteries, however, require slightly different treatment, we procured instruction books from some of the battery manufacturers regarding his particular battery and forward them under separate cover to the boys taking up this A. B. C. Car Lighting Course.

Please consider that these instruction books become a part of this lesson and read them over carefully as questions will be asked which can only be answered by refering to these instruction books. They are more than usual catalogues, they contain a lot of information that will help *you.*

Charge.

When a battery is charged it does not mean that the electricty itself has been stored up in that battery as you would fill a tank full of water—battery charging simply causes a chemical change in the battery plates, changing the negatives to pure spongy lead and the positives to peroxide of lead. If we could take the plates of a discharged battery right out of the cells and effect these same changes by chemical means and then replace the plates, the battery would be up to full capacity just as if full charging current had been forced through it. It is only because of the convenience of the electric current which causes the proper chemical changes to occur that we use that method of charging.

To charge a battery the current must be forced to flow in the reverse direction from that of discharge and to accomplish this the voltage of the generating source from which the battery is charged must be slightly in excess of the battery voltage. Great care must be taken that the battery is connected in the right direction with the charging circuit, that is, the battery positive connected to the generator positive, etc., otherwise a serious short circuit would occur. Some battery manufacturers pre-

fer to have their batteries charged at the normal 8 hour rate and others at twice this rate until the cells begin to gas when it is reduced to normal..

As the charge proceeds the voltage will gradually rise to a maximum and unless the voltage of the generator is raised correspondingly, the charging current will gradually fall off to a low rate or practically 0. So a battery on charge should be carefully watched and the current flow adjusted to proper value every 15 minutes or half hour.

Be careful that the cell does not overheat. This should be watched very carefully for if the temperature goes above 110° F., it is very apt to badly sulphate the battery, and seriously injure it. If the temperature does get up to this point, stop the charge or reduce it to a low rate until battery cools.

As the charge proceeds the battery voltage will rise higher and higher until near the end of charge it will reach a maximum point. After that point the charge should be continued *keeping the current constant at the normal rate* until the voltage reaches this maximum and then does not rise any further for a period of a half hour with normal charging current flowing. It is impossible, for us to say just what voltage that will be, for the voltage at the end of charge depends upon a number of things as follows:—

(I) Charging current flowing. (II) Temperature (III) Type and condition of plates.

(I) The higher the current flowing the higher will the charging voltage be, and the smaller the charging current flowing, the lower the charging voltage that will be required.

(II) If the battery is very cold, say down below freezing, it will require a higher charging voltage and if it is hot it will become charged at a lower voltage than at normal temperature. The battery warms up as it is charged, and in hot weather this must be watched very carefully or it will overheat.

(III) If one or more of the cells have become "Sulphated" it will cause the charging voltage of the battery to be higher than normal.

As the charge is about finished the plates will begin to gas which shows that the chemical action caused by the charging current in converting the plates back to lead sponge and lead peroxide has been completed.

These gases given off, however, are oxygen and hydrogen and they form an explosive mixture, so *never bring a torch, match or candle near a battery* that is charging as this will explode the mixture and cause you personal injury.

Two of the car lighting boys, to the writer's knowledge, are each now deprived of the sight of one eye because in inspecting a battery one of them foolishly struck a match to see if the battery was still there. This caused a violent explosion which resulted in the loss of one eye to each of them.

You must realize that these bubbles are formed not only on the surface of the plate, but deep down inside the active material as well. A slight gasing occurs at the finish of every charge, but on over charge this becomes violent and loosens the active material from the plates. This falls to the bottom of the cell forming a brown sediment which must be cleaned out periodically for if the layer of sediment becomes so deep it touches the plates, it will short circuit them and completely discharge that particular cell. This is not cinders nor dirt—it is the very life of the plates themselves. This excessive gasing which is the main cause of this sediment should never be allowed to occur except on the monthly overcharge.

In the normal operation of a battery there is a slight deposit of this sediment on every charge and discharge although this is so small as to be hardly appreciable. It is the violent overcharging, especially after plates have been somewhat sulphated or when a battery is warm, that causes rapid loss of active material.

(Battery Lesson to be Continued next month.)

Practical Stunts.

We pay for ideas published in this section. Send in some of your stunts . . . never mind about the fine grammar.

To the Editor.

For several years we have been operating a number of old Bliss Bucker type 64 volt car lighting systems and it was recently decided to change these to 32 volts. I removed an equipment from a car and started to make a series of tests to find out just what would be required to accomplish this change. I found that this could be done at approximately $3.00 per car for labor and material and incidentally a big saving in the number of storage batteries effected. I did not change the field coils in either of the dynamo or the bucker. I simply removed the 60 volt lifting coil from the automatic switch and applied a 30 volt coil. I then connected up 16 cells of battery in series where formerly 32 had been installed and started the motor which was to drive the test equipment.

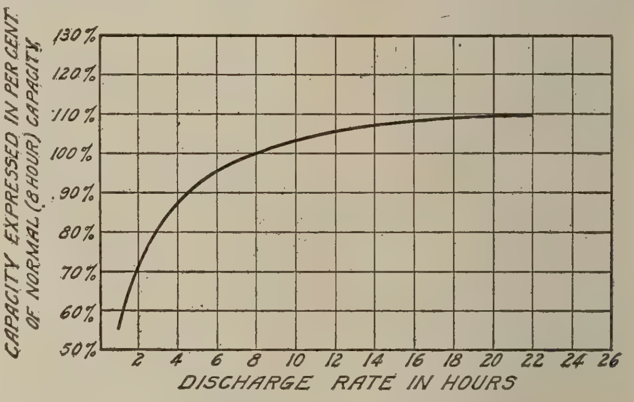


Fig. 16. Curve Showing Variation of Battery Capacity with Discharge Rates.

The automatic switch closed at 400 r. p. m. and I then speeded the motor up to 1800 r. p. m. to see if the generator heated up at high speed. There was no more heating effect than in normal operation, in fact, a little less although the same battery charging current flowed as would have occurred in normal operation at the train speed equivalent to that speed of the machine.

This test was so successful that I applied the equipment back to the car and on the first trip rode the car from Boston to Albany. Herewith is a brief log of the road test.

Lights Off.

1. Automatic switch closed when the train was going about 12 miles per hour. The ammeter in the generator circuit registered 30 amperes at 40 volts with a train voltage of 15 miles, while the lamp voltage was 32 volts, there being a drop of 8 volts across the lamp bucker armature.

Lights On.

2. Generator current 45 amperes at 40 volts. Lamp voltage 32. This reading was taken when the train was going at a high rate of speed.

I have changed all the B. & A. cars in this manner and the service has never been better. As our line is rather hilly the time on certain divisions is slow, and where a 64 volt system would not work, a 32 volt would.

L. B. Knight, B. & A. R. R.

SPEED DIAL FOR MOTOR DRIVEN TOOLS.

With the advent of high speed steels and the continual trend toward scientific management and efficiency methods in all machine tool operations, it is exceedingly important to have some accurate method by which the machine tool operator can easily adjust his driving mechanism so as to give the prescribed speeds at the cutting tool under changing conditions of work.

Where the speed changes are accomplished by means of cone pulleys or gears, the spindle has a certain number of known, definite revolutions per minute, usually indicated on the name plate of the machine, and it is a comparatively easy matter to embody in

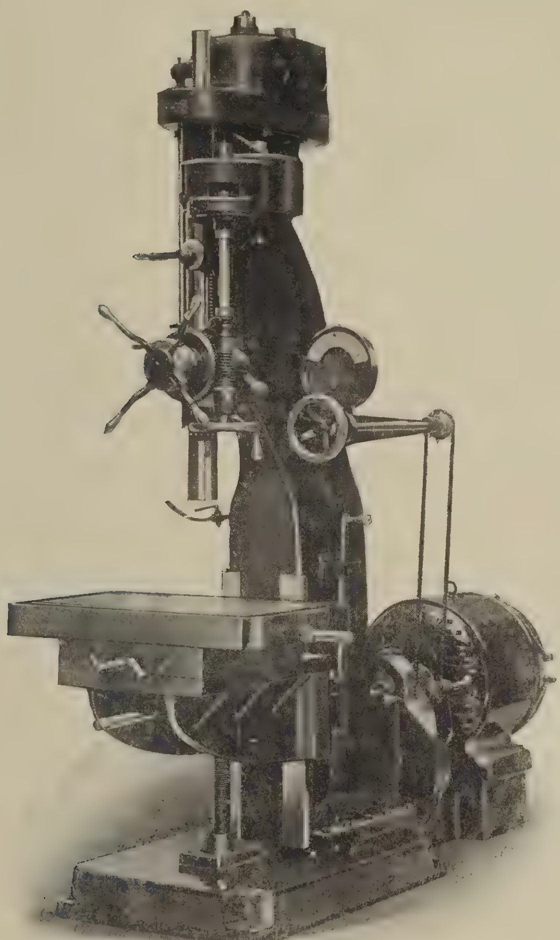


Fig. 1. Speed Dial on Crank Shaper.

the blueprint for the work in question specific instructions showing the step of the cone pulley or gear combination at which each operation can be performed to give maximum efficiency. With individual adjustable speed motor drive, however, the speed combinations are much greater in number, are not as easily calculated, and the proper speed setting is usually left to guess work or the personal equation of each individual operator with the natural differences in efficiency which such a method would give.

In the case of the Reliance adjustable speed motor of the armature shifting type an infinite number of speed changes is obtained. As the armature is shifted there are no steps or jumps but a smooth, gradual, continuous change in speed. On a machine tool driven by this type of motor, it is necessary to make the approximations in speed setting required with other speed change devices, and it is always possible to obtain the exact cutting speed desired provided the operator has some means of accurately adjusting the speed of the motor to that required and does not have to guess at the speed at which the motor is running. Such a device has now been developed by the manu-

Fig. 2. Detail of Speed Dial.

facturers of this type of motor and is illustrated herewith.

The speed dial can be mounted at any convenient point on the machine tool, and it is simply necessary that it has some positive connection with the means employed for shifting the armature of the motor. As the armature of the motor is shifted and the gradual change in speed obtained, a pointer moves in the speed dial. The scales in the dial take into account the different gear ratios between the motor and the work, and can be set or different cutting speeds at the cutting tool, depending on the cutting speed used and the character of the work. The device is, therefore, not a means of indicating the speed at which the motor is running, but is in reality an automatic calculator by which the operator can instantly set the speed of the motor so as to give any desired speed at the cutting tool, taking into account all the variable factors which would affect the problem. All the operator has to do is to set the dial for the cutting speed to be used and then shift the armature of the motor in the usual manner until the pointer indicates the diameter of the cut to be taken on the proper scale for the gear combinaion used.

The dial not only serves as a guide in setting the speed accurately, but is always in plain sight as a definite indication to the foreman or inspector of the speeds in use by the operator. These dials can be furnished properly calibrated for use with Reliance Adjustable Speed Motors on shapers, drills, lathes, milling machines, boring mills or any type of adjustable speed tool. It is manufactured by the Reliance Electric & Engineering Co., Cleveland, Ohio.

This shows a dial arranged for a crank shaper with one back gear. The upper scale indicating cutting speeds is stationary. The small indicator standing at 40 is mounted on revolving disc with two lower scales. Lower scales showing length of stroke are adjusted by means of knurl on front of dial until indicator points to cutting speed desired. Scales are not shifted unless new cutting speed is to be used. With scales set on any cutting speed motor armature is then shifted by turning hand wheel illustrated in Fig. 2 until pointer of dial which is geared to hand wheel rod is opposite stroke to be used. Dial illustrated is set for

forty feet a minute with motor speed adjusted for twenty inch stroke with back gear in. Bottom scale shows stroke with back gear out.

FLEXIBLE STEAM HOSE COUPLER.

All operators of headend car lighting equipments will appreciate the importance of a new steam hose coupler which has just been brought on the market by the Joseph Goetz Mfg. Co., of Cleveland, Ohio.

The coupler is shown disconnected in the accompanying photograph from which some detail of construction can be observed.

The joints are pressure packed and are all tested to 1,000 lbs. hydraulic pressure. They are of all metal construction and accordingly should be of long life. This coupler will take up any motion between cars without

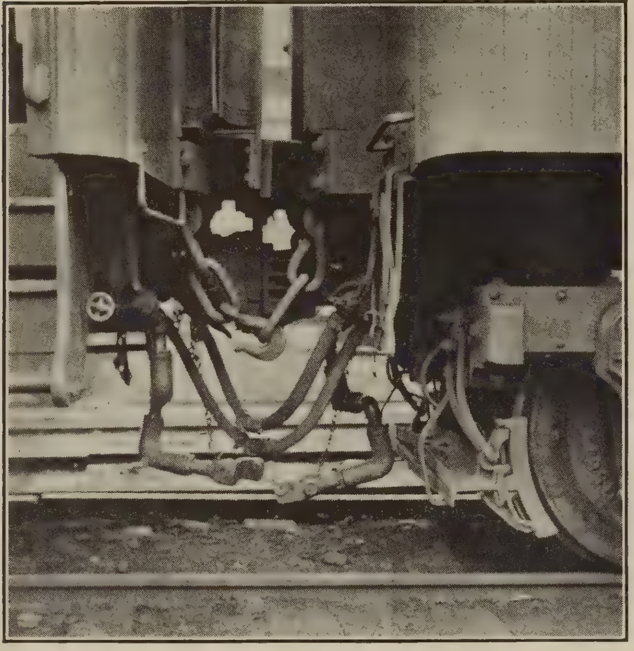


Fig. 1. Showing Steam Hose Coupler Disconnected.

leakage of steam. It should be noted that they are interchangeable with ordinary steam hose connectors as they have the same style coupling heads. The safety chain acts as an automatic uncoupler if the cars are uncoupled without disconnecting the steam hose. A dust guard prevents dust and dirt from accumulating around the stems.

The manufacturer is placing these couplers on the market with a guarantee of two years life and claims that they should last as long as the car to which they are applied as they are entirely of metal construction, with the exception of the packing.

HAND BOOK ON CIRCUIT BRAKERS.

The Cutter Company has just issued a very complete yet condensed hand book on the subject of circuit brakers. This book is thumb indexed to make it more serviceable and contains about all the information an engineer needs to know in ordering or specifying circuit brakers. A copy of this book will be furnished the Senior Active Members of the Association upon request from the manufacturer.

John B. Given, Sales Manager C. H. Whall & Co., Boston, has opened an office in the Postal Telegraph Bldg., New York City, to handle Railroad Holophone Reorganization Specialties.

HOLOPHANE RE-ORGANIZATION.

The General Electric Company has recently completed negotiations for taking over the entire Holophane organization consisting of both Sales and Manufacturing Departments. The Fostoria Glass Specialty Company will be united with the Holophane organization, probably in the form of a new company. The sales and engineering parts of the business will be directly under the charge of Mr. V. R. Lansingh, while the manufacturing will be under the charge of Mr. E. O. Cross.

SALES NOTICE.

The Remy Electric Company, Anderson, Indiana, has just received an order from the Canadian Pacific Railroad for twelve American Locomotive Electric Headlights.

SHERARDUCT.

The National Metal Molding Company, of Pittsburg, have just issued a mailing card showing some very attractive cuts of buildings in which Sherarduct has been installed exclusively.

TRAIN CONNECTOR BULLETIN.

"The Delta-Star Electric Company of Chicago, have issued a new twelve page bulletin describing their automatic and non-automatic types of train connectors for use in car lighting. The bulletin is profusely illustrated and will be found of value to those interested in modern car lighting."

Patents of Recent Issue.

1,016,874. Means and Method for Preventing Depletion of Electrolyte Thomas A. Edison. Means for Causing Recombination of Oxygen and Hydrogen Gases formed by Decomposition of Electrolyte. This is accomplished by platinum sponge, platinum oxid or finely divided platinum wires placed in the electrical circuit. Means may also be provided for heating and drying the gases given off, so that they will combine more readily. This should make it unnecessary to flush the battery.

1,019,482. Charging Storage Batteries P. Kennedy. Is an improved method of charging storage batteries so as to insure the battery shall be automatically charged to full capacity, or preferably slightly overcharged, and yet prevent excessive overcharging.

Motor drives gear by means of one or more of five adjustable pinions operating, by means of a long threaded screw, a recording stencil, indicator and carriage which operates certain switch relays controlling the lamp circuits. As the battery charges this carriage will move to the right indicating the number of hours battery is charged. When the battery becomes fully charged the carriage will close a relay at which time the generator output will be reduced to a low value provided that the battery voltage is up to a certain predetermined point.

On discharge the carriage will move back to the left at a rate proportional to the number of lamps in circuit. When the battery discharges down to a predetermined point, carriage can automatically close a relay which will cut off one or more of the light circuits. If the battery continues discharging down to the lower limit, another relay may be arranged to operate which will cut off all the lights and prevent battery from over-discharging.

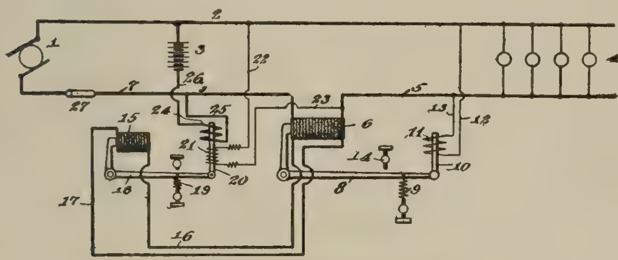
1,019,483. Electric Current Supply System P. Kennedy. Modification of 1,019,482.

1,019,484. Electric Switch P. Kennedy. A switch to be employed in a circuit feeding lamps which will close the main feeding circuit whenever any local lamp switch is closed. Whenever there is no lamp current flowing, switch will open. This is effected by main relay which is controlled by a secondary relay in the lamp circuit.

1,020,479. Electric Regulation John L. Creveling. Assignor to Safety Car Heating and Lighting Company. A carbon pile is placed in parallel with the lamp regulating resistance and the pressure on this pile is caused by the magnetic pull of a compound solenoid opposing an adjustable spring. This solenoid consists of a shunt winding placed

across the lamp circuit and of a heavy series winding placed directly in the battery circuit. When charging current flows series coil will augment the magnetic pull of the shunt coil releasing the pressure on the carbon pile and increasing its resistance On discharge the series coil will oppose shunt coil so that the heavy spring will strongly compress carbon pile and provide a path of low resistance in parallel with lamp regulating resistance.

1,016,825. **Apparatus for Producing a Constant Voltage with Variable Speed.** Provides a double winding on the armature with double set of brushes generating two voltages, one for the lamp circuit and another, somewhat higher, for the battery circuit.



1,020,479 Lamp Regulator Diagram.

1,020,568. **Alkaline Battery** Wm. Morrison. Active material for positive plate consists of oxids of mercury, copper and silver.

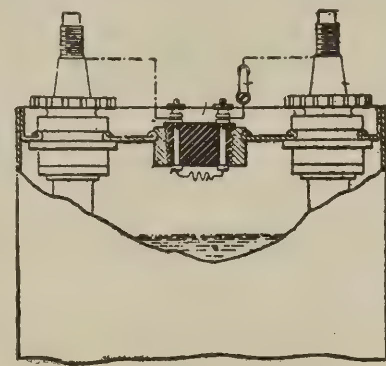
Sockets, P. H. Robinson, assignor to Scovill Manufacturing Co., Waterbury, Conn. Consists of a shade-holding ring with rabbeted flange fitting on a spring collar.

1,017,670. **Voltage Regulator.** R. P. Jackson, assignor to Westinghouse Electric & Manufacturing Co. An alternator field has in series with it a resistance and is fed from a mercury-arc rectifier connected through a transformer across one phase of the alternator leads.

1,017,110. **Lock for Electric Plugs.** E. E. Rogers, assignor to Foster Engineering Co., London, Eng. A battery-charging plug is retained in position (as long as current flows) by the core of a solenoid projected through a hole in the plug stem.

1,017,080. **Storage Battery.** J. P. Clare, Stratham, N. H. Has porous plates with their edges formed to present an abrupt edge between the electrodes.

1,017,280. **Process of Increasing the Ductility of Metallic Tungsten.** W. von Bolton, assignor to General Electric Co. Consists in treating tungsten at high temperature with hydrogen and proctochloride of sulphur, then passing an electric current through the mass in an inert atmosphere and thereby expelling the sulphur.



1,016,874 Device for Battery.

1,015,613. **Electric Switch.** G. A. Burnham, assignor to S. B. Condit, Jr., Boston, Mass. An oil switch in which the main and auxiliary movable contacts are carried by a cross-head.

1,016,037. **Electric-Lighting System for Vehicles.** S. W. Rushmore, Plainfield, N. J. Includes a generator driven at varying speed, a storage battery, a ballast for absorbing the excess voltage of the dynamo, and an automatic regulator and switch.

1,015,192. **Electric-Current Measuring Instrument.** O. A. Knopp, Oakland, Cal. The current-carrying conductor is placed in a gap in an annular ring; the instrument is connected to a winding about the ring.

1,019,044. **Electrical Coupling.** J. L. Hinds and J. J. Dossert, assignors to Crouse-Hinds Co., Syracuse, N. Y. A threaded stem has a loop terminal with a hinged section that can be secured by a lock nut.

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OUR OBJECT.

The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.

In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.

CONTENTS

Potential vs. Current Regulation of Axle Equipments.

This is the title of a series of talks to be given by representatives of the various manufacturers at the coming semi-annual Convention of the Association at Atlantic City as announced in the Association News in this issue.

With but one exception, all of the regulators devised for operation in connection with car lighting equipments up to the present time are operated on the principle of controlling the generator current to a predetermined value. The voltage generated accordingly has followed directly the rise in battery voltage on charge. That is, if the battery happened to be in a condition of low charge its charging voltage would be low and the lamp voltage correspondingly low. On the other hand, if the battery happened to be in a fully charged condition, the same charging current, under similar conditions of train speed and lamp load, would be forced into the battery and the generator voltage would rise to a condition high enough to force that charging current to flow.

The result of this was that the voltage generated would follow directly the battery charge curve giving a variation of from 30 to 42 volts, on a 30 volt equipment, or practically 33% rise in voltage. This was instrumental in burning out a great number of lamps in the early days.

Various types of lamp regulators were employed in an attempt to protect the lamps from this excessive variation in voltage. These, however, without exception depended in one way or another upont the amount of current flowing either in the battery circuit or in the lamp circuit. Accordingly while they might compensate for variation in number of lamps in service and for train speed, they did not take care of the main difficulty: that of varying voltage due to condition of battery charge.

The introduction of the independent lamp voltage regulators within the last six years by all of the various manufacturers of axle equipments has largely overcome this difficulty of variation in generator voltage so that the subject of potential regulation is not of as great importance today as it would have been six years ago.

It is understood that certain manufacturers have, however, developed some good generator regulators which operate on a combination current and potential basis, and we shall wait with exceeding interest their presentation of the matter before the June Convention of the Association.

Evolution of the Box Type Fixture.

Two years ago when the first concealed box type fixtures were installed on Lake Shore diners they caused considerable comment among railroad men, much of a favorable nature but some adverse. That they were highly efficient and gave an excellent distribution of light on the table, entirely eliminating the usual glare of car lighting installations previous to that time, was conceded by all. A serious objection however was raised by some, in that the ceiling was left dark and unilluminated since the light units were entirely concealed in the quarter deck. Subsequently one of the big fixture companies designed a box type fixture which was described in the January, 1910, issue of the RAILWAY ELECTRICAL ENGINEER with the idea of securing a slight ceiling illuminating by lowering the unit, mounting it on a short base and providing art glass sides. The same bottom prism plate as originally used was employed in this fixture.

The new hexagonal fixtures installed on the Lake Shore buffet cars, described in another part of this issue, marks another step forward in that it introduces a new type of bottom plate which is of slightly pyramidal form. This feature adds very materially to the artistic appearance of the fixtures in the car. The arrangement of the prisms in this plate also effects a marked improvement in light distribution over the original flat plates.

Electric Locomotive for Southern Pacific Co.

Six direct-current 60-ton Baldwin-Westinghouse electric locomotives and 20 Westinghouse car equipments with H L control have been purchased by the Southern Pacific Company for operation on the Southern Pacific and the Pacific Electric Company properties.

Both the car and locomotive equipments are arranged for operation on either 600 or 1,200 volts. Most of the lines now operate at 600 volts but there are portions served with 1,200 volts and the double-voltage equipment was selected so that it might be used on any portion of the system and on such 600 or 1,200-volt extensions as may be built in the future.

The 60-ton locomotives, each of which will have an aggregate motor capacity of 1,000 horsepower, will be the largest 1,200-volt, direct-current locomotives ever built. They will have quadruple equipments of commutating-pole motors that are rated at 225 horsepower at 600 volts with natural ventilation and 250 horsepower at 600 volts with forced ventilation. This motor has all the characteristic features of Westinghouse railway-motor construction, such as spider armature construction, rugged brush-holders and oil and waste lubrication.

Because of the large capacity of the motors the duty on the control equipments will be very severe. Westing-

house H L control, which has already demonstrated its fitness for controlling motors of great capacity on the Pennsylvania locomotives, will be used.

The mechanical parts for the locomotives will be furnished by the Baldwin Locomotive Works. The cabs and frames will be entirely of steel.

A Westinghouse dynamotor-compressor will be used on the cars and locomotives for operating the air compressor and for furnishing 600-volt current for both control and light circuits when the equipment is on the 1,200-volt sections of the line.

The 20 passenger cars will be furnished by the Pullman Palace Car Company. Each car will have quadruple equipments of Westinghouse commutating-pole motors each rated at 50 horsepower.

Association News

Semi-Annual Convention in June.

The semi-annual convention of the Association is to be held June 14th at Atlantic City. This comes the same week as the M. C. B. convention, which is also held at that place, with the Master Mechanics' Convention the week following. As usual at these conventions there will be a large display of railway appliances on Young's Million Dollar Pier.

The program of the semi-annual convention is tentatively laid out as follows:

1. "Shop Motor Equipment," by A. I. Totten and F. H. Herzsch.

Special attention will be given the subject of group drive vs. individual drive and the relative merits of the various types of motors for this service will be considered.

2. "Mail Car and Coach Lighting," by A. J. Sweet and L. Schepmoes.

Special consideration is to be given the matter of mail car lighting and it is understood these gentlemen have something pretty fine up their sleeve which is not yet available for publication.

3. "Potential vs. Current Regulation of Axle Equipments."

An engineer from each of the following companies will be present and give a short talk on this subject: Cons. Ry. Elec. Ltg. & Equip. Co., Goulp Coupler Co., Safety Car Htg. & Ltg. Co., U. S. Lt. & Htg. Co.

4. Progress reports of all the various committees, new, unfinished business, etc.

Considering the above excellent program and the fact that this meeting is to be held at Atlantic City, where we will be able to view the great line of exhibits of the various railway supply companies, this is the most attractive and should be the best attended semi-annual convention we have ever held. Every senior active member should be present and as many of the juniors as can get there.

Next Meeting of Car Lighting Club.

The May meeting of the Car Lighting Club is to be held Wednesday, May 15th, at the usual place, Kunz-Remmlers Restaurant, 424 S. Wabash Ave., 3d floor. Subject of the evening will be "Troubles and How to Shoot'em." Mr. H. G. Myers of the Santa Fe, will open the discussion telling us a few of his troubles, but that will only be a starter, for everybody will come loaded with trouble—however, no guns or razors allowed and please check your chewing gum at the door.

This ought to be the best meeting of the year but we have got our fingers crossed for the weather man may slip one over like he has at every one of our meetings for the last six months. But in any event if you are within 500 miles of Chicago and don't get to this meeting you will probably spend the rest of the week regretting the fact.

If you can't be there yourself tell your troubles to Myers, 18th Street Yards, Santa Fe R. R., Chicago, so he can bring them up to the meeting.

NEW EQUIPMENT ON NEWYORK CENTRAL LINES

An order for 300 new car lighting equipments, mostly for coaches, some old and some new, was recently placed by the New York Central Lines. These are to be equipped with electric lighting equipment throughout, no auxiliary whatsoever being supplied.

Type G., 2-kw., 30-volt Gould "Symplex" equipments are to be installed with 13 plate D. S. 80 B., 300 ampere hour Gould car lighting type storage cells.

LAST MEETING OF CAR LIGHTING CLUB.

George W. Cravens addressed the April meeting of the Car Lighting Club on the subject of, "Planning and Equipping of Railway Shops," treating the matter from the viewpoint of a railroad company building a new shop or planning extensions to its present equipment. The subject was such a large one that Mr. Cravens found it difficult to give all the various points sufficient consideration, but discussed in detail the electrical features, such as motor drives, power transmission, etc. He also presented much valuable data on power required to drive various types of machine tools under various conditions of service. Mr. Cravens said that after all preliminary data was secured and the size and location of the shops determined upon, the arrangement of the buildings is the next, and a very important thing to be determined: The various kinds of shops required were then taken up in rotation, and their arrangement, size, equipment, etc., discussed.

He said that both alternating and direct current motors are used in railway shops, many installations being entirely of one type or the other. Mr. Cravens then explained at considerable length, the characteristics of each of the three kinds of direct current motors; series wound, shunt wound and compound wound, pointing out features which adapt each of these motors to a particular class of service. The various types of alternating current motors were then treated in the same manner, synchronous and induction motors being discussed in detail. Mr. Cravens said that the induction motors with their adjustable commutators and rheostats had been developed to such a degree as to make induction motors applicable to almost any kind of service.

In regard to the matter of size of motor, he said that there is no better way to determine this than to put a motor on a machine similar to that under consideration and take readings of current under different conditions of operation. The size of motor required, however, may be closely approximated in the following manner:—H. P. =F x D x S x C when H. P. is horsepower, F is the feet in inches D is depth of cuts in inches, S the speed in inches per minute and C a constant, depending upon the material worked.

The values of C are as follows: cast iron, 0.35 to 0.40; soft steel or iron, 0.45 to 0.50; hard and machine steel, 0.70 to 0.80; crucible steel 1.00 to 1.10.

Mr. Cravens pointed out the fact that average load of a machine shop seldom equalled more than 30 per cent of the combined rated capacity of the motors connected. Accordingly it becomes advisable to consider the possibility of grouping such machines as drill presses, grinders, etc., in order to keep the motor installation cost down to a minimum. In closing he emphasized the low cost of maintenance and the great saving in line losses of electrical system of distribution of power over those of the old power mechanical line shaft transmission.

New Hexagonal Fixtures on Lake Shore Buffet Car

The new buffet car No. 177 on the Lake Shore, illustrated herewith, offers an excellent example of combining artistic beauty in lighting fixtures with high efficiency and uniform distribution. The car is the usual combination buffet car with barber shop in the center and baggage room occupying the forward end of the car.

Fig. 1. Interior of Library Compartment Showing Hexagonal Fixtures.

In the library compartment as shown in the accompanying illustration there are 14 hexagonal box type fixtures. They are arranged to accommodate a single 50 watt tungsten lamp of the skirted base type. A special prismatic reflector with special bottom plate designed by the Holophane Co., now the Nelite Works of the General Electric Co., is supplied. This is made in an octagonal shape to fit the fixture exactly and the special ribbing of the prisms should be noted.

In the half deck fixture, one of which is shown open in Fig. 4, these are so arranged as to throw the light away from the wall, giving an assymetric distribution curve in a transverse plain as shown in Fig. 2. This, however, gives a much more efficient distribution of light in the car, as it eliminates the excessive loss of light on the wall due to the fixture being placed but 13" from same. This throws the light down onto the papers and magazines of the passengers where it is most needed. An indentation is made in one side of the bottom plate to receive a lug cast in the brass frame of the fixture. This makes it impossible to place the bottom plate in wrong. This feature is very essential and should always be included.

The reflectors in the center deck fixtures have a symmetrical distribution curve in both transverse and longitudinal plains but are arranged to give a much more intense illumination up and down the car than sideways toward the walls.

The detail design of the fixture itself is both artistic and practical. An art glass panel 2" wide on each of the 6 sides gives a warm color tone to the fixture and provides for lighting up the car ceiling to a certain degree. The fixtures are finished in brush brass and the car is decorated in mahogany with a ceiling of a rich ivory panels.

The bottom prism plates are cast in a slightly inverted pyramidical form which gives a much wider angle to the distribution curve and at the same time allows a small amount of light to be seen by the passengers. This latter point, although from a visual acuity basis is bad, from the artistic point of view and the point of view of the public wishing to see some of the light, it may have its advantage. In any event, it is so small as to be of little considtration.

The reflector is of the standard focusing type in the upper section, but lower border of the skirt is molded

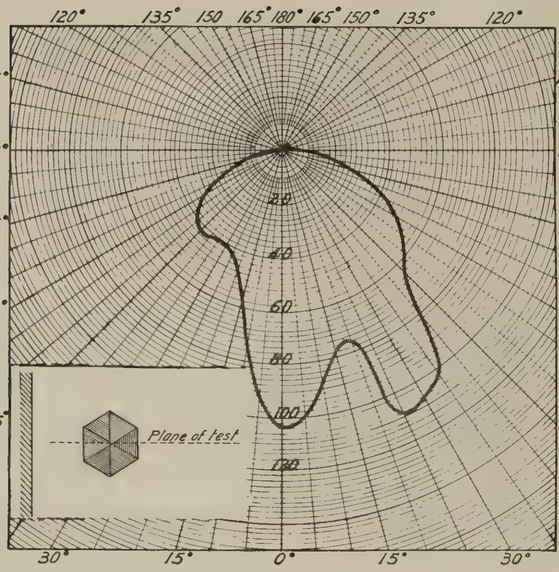

Fig. 2. Distribution Curve Plane Perpendicular to the Wall.

into an hexagonal shape to fit the inside of the fixture. This is held in place by three flat spring bands which carry a supporting lug. These spring bands press against the reflector so that they serve the double purpose of supporting it vertically and holding it firmly in place horizontally. The three other flat band springs engage the reflector near the top so that it is held securely in place on all sides by springs and all trouble from jar is

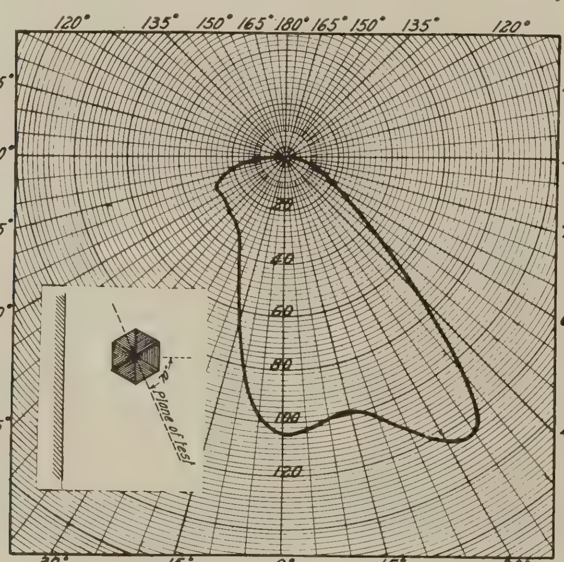

Fig. 3. Distribution Curve Plane 20 with Wall.

eliminated. It is but a moment's work to remove both reflector and prismatic bottom plate. It is only necessary to press back two of the three supporting springs to remove or install the reflector, while the prism plate is held in place by little spring dogs, tightened by a screw, and can easily be removed with a screw driver. A gyro fan supporting pendant base is mounted between each of the center box fixtures and its design harmonizes well with that of the fixture itself. In the summer time gyro fans which provide ample agitation of the air within the car are mounted on these.

A type D Consolidated 50 volt axle equipment with Kennedy regulator and 32 Willard train lighting cells of 320 ampere hour capacity furnishes light for the equipment.

Test.

A test of the illumination of this car was made with a small portable hand illuminometer, and while these readings are not of much absolute value, they are of sufficient accuracy to give at least a general idea of the illumination obtained. Three tests at each station were made and the average taken as the illumination at that point. In no case did any reading vary more than .2 of a ft.

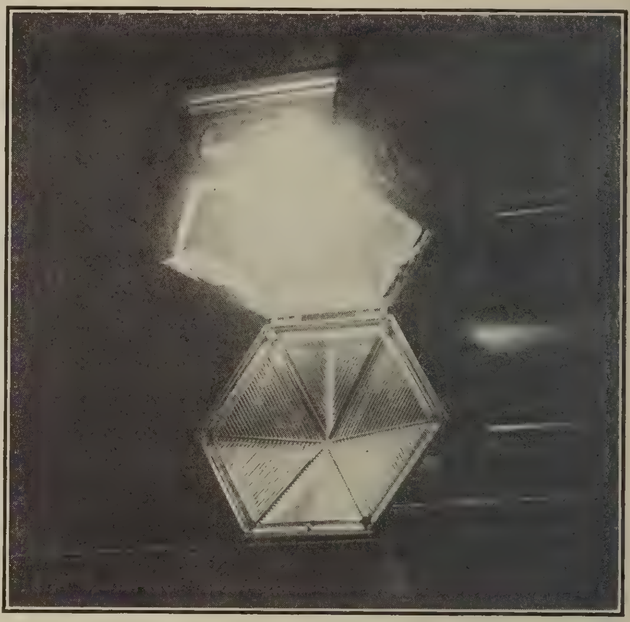

Fig. 4. Showing Hexagonal Unit Open.

candle from the average, the usual variation being .1 ft. candle either way. These intensities are given in the following table, and their average may be fairly taken as the average illumination in the body of the library car. Observations were taken in a horizontal plain 36" above the floor and 2 ft. from the wall. As the chairs are large and heavy, they are very seldom moved out of place

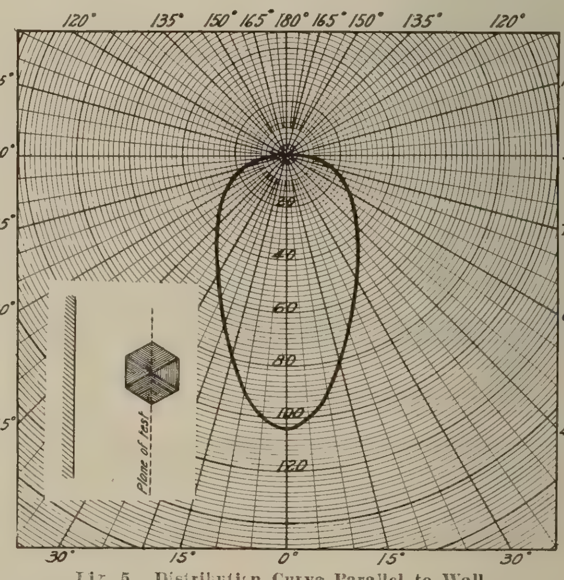

Fig. 5. Distribution Curve Parallel to Wall.

when the car is in service, so readings were taken at each chair.

In these tests it was found that there was an illumination of approximately 4 ft. candles at a point 3 ft. above the floor and 2 ft. from the wall at each of the seats. This is approximately the point at which a reader holds a book or paper when he is reading. The average illumination found in the center is approximately 3.4 ft. candles, giving a total average for the car of 3.7 ft. candles.

The car is lighted by 14-50 watt tungsten lamps, which consume 700 watts. This compartment is 31′ 4″ x 9′ 2″, 286 sq. ft., so the wattage represents 2½ volts per sq. ft.

RESULTS OF TEST.

Station No.	Ft. Candles.	Station No.	Ft. Candles.
1.	4.2	10.	4.1
2.	4.2	11.	3.2
3.	3.9	12.	3.1
4.	3.9	13.	3.7
5.	4.0	14.	3.4
6.	4.1	15.	3.0
7.	3.9	16.	3.2
8.	4.1	17.	3.7
9.	4.0	18.	2.9
		19.	3.7
		20.	3.8

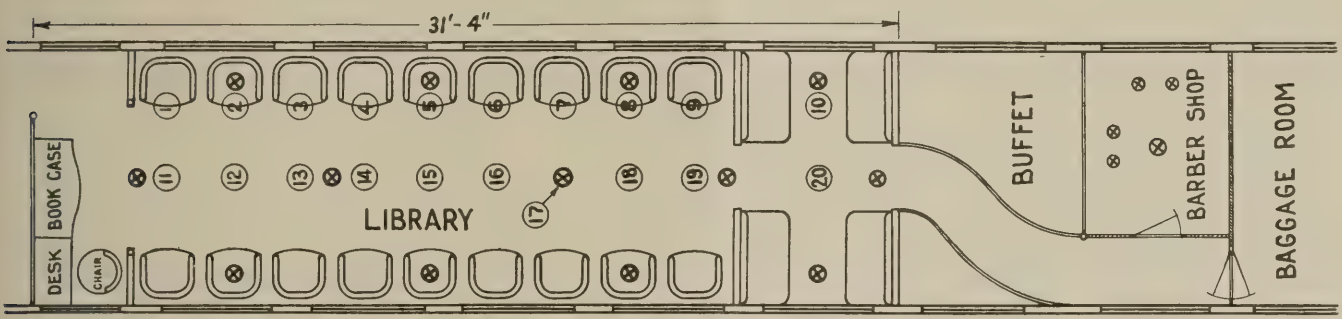

Fig. 6. Plan of Car with Test Stations.

The Use of Alternating Current in Unloading Coal*

BY W. N. RYERSON AND J. B. CRANE

The receipts of coal in Duluth-Superior Harbor increased from 2,600,000 tons
1910. This coal comes principally from Pennsylvania and West Virginia and is brought by rail to Lake Erie ports where it is loaded into boats for transportation to Duluth and Superior. Of the receipts in 1910, two million tons were anthracite and the remainder bituminous coal. At Duluth-Superior Harbor the coal is unloaded from the boats and stored for future demand or loaded directly into cars for shipment to various points in Minnesota, North Dakota and Montana.

The storage capacity of all the docks at this port increased from 1,000,000 tons in 1900 to over 5,000,000 tons in 1910.

In 1906 there were two docks equipped for the use of electrical energy, both using direct current, one of them purchasing current from the local lighting company and the other owning and operating its own generating plant. In 1911, eleven of the twenty-one coal docks were equipped for the use of electrical energy and nine of these are using alternating current directly on the hoisting apparatus while another has installed a synchronous converter in order to supplement its existing direct-current generating equipment by the use of purchased power.

In 1909, twenty-six per cent of the coal received was handled by electrical energy, in 1910, forty per cent, and in 1911, it was estimated that sixty per cent of the total coal received would be handled by the use of electricity.

Before the introduction of electrical energy, the largest dock had a storage capacity of 250,000 tons, while two of the newer docks have storage capacities of 1,000,000 tons each and another is projected of this same capacity but with provision for an ultimate storage of 2,000,000 tons.

*Paper presented before the Pittsburg meeting of the American Institute of Electrical Engineers, April, 1912.

The coal handling machinery as at present installed is divided into three types: bridge tramway, cable car, and man trolley.

Bridge Tramway. The installation consists of moving bridges, locomotive cranes, box car loaders, and screening towers.

The boats are moored to the unloading side of the dock. In case the unscreened coal is to be shipped out immediately the bucket takes the coal from the boat and loads it into the cars at the opposite end of the dock. In case the coal is to be screened the bucket carries it to the rear end of the dock and dumps it into the screening towers. Moving buckets carry the screenings on to the screenings pile at the rear of the dock. The screened coal is loaded into cars by gravity. Coal for storage is dropped directly onto the storage pile.

Twenty-five-cycle, three-phase, 13,000-volt power is delivered to the terminals of a transformer house. Three 500-kw, three-phase transformers reduce the pressure to 440 volts for distribution about the dock. This distribution is accomplished in a novel manner. Posts about four ft. high, are spaced at intervals along both ends of the dock. Three contacts about 15 in. apart are placed vertically on these posts and the current is transferred to the moving machinery by means of shoes, which span two posts at a time. The cables for supplying current to the contacts are carried in troughs about one ft. above the ground and protected by means of metal covers, which can be easily slipped off for the purpose of making repairs to the cables.

The bridges have an extreme length of 506 ft. The buckets are controlled from cabs at either end of the bridge. They operate by means of cables running over sheaves from the cabin on top of the bridge. One 225-h. p., three-phase, 440-volt wound rotor motor drives the hoist for closing and hoisting the bucket. For moving the bridge two 75-h.p. motors are used.

The buckets are all of the clam shell type and on three of the four bridges on this dock weigh seven tons and hold three tons of coal. The fourth bridge, installed in the spring of 1911, has a bucket weighing six tons and hoists four tons of coal. On this latter bridge a 375-h.p. motor is used for hoisting and closing the bucket and one 225-h.p. motor for moving the bridge.

The older type of bridge has a hoisting speed of 300 ft. per minute and was guaranteed to make 60 trips and unload 180 tons of coal per hour, and has made 100 trips and unloaded 300 tons of coal in one hour.

The new bridge has a hoisting speed of 600 ft. per minute and has shown a capacity of 500 tons of coal per hour. This bridge has proved so successful that it is proposed to install similar apparatus on one of the other bridges this winter.

The control system on the bridges is alternating-current magnetic control and has given no trouble in three years of operation.

The braking is done by means of friction brakes released by solenoids. Hardwood shoes were at first used for this purpose. These caused considerable trouble from heating, and for the past two years asbestos shoes have been used with good satisfaction.

The locomotive cranes are equipped with 75-h.p. wound rotor motors and are used for moving cars, hoisting coal from the screenings pile into cars, and loading coal from the side of the main pile into the loading hopper.

The box car loaders are equipped with 12-h.p. wound rotor motors. These machines are used for moving cars and loading coal into box cars. Most of the cars loaded are of this type, the cars bringing wheat to Duluth and taking coal from Duluth. The loaders have an arm extending into the door of the car on the side opposite the receiving spout. The coal strikes the end of the arm and is thrown first to one end and then to the other by means of a reversible scoop operated from the cab of the loader by the operator.

All the electrically operated docks use the same type of box car loader.

The screening towers consist of hoppers into which the coal is dumped, and from which it falls into the car over screens. The screenings are emptied on to the screenings pile by means of moving buckets, operated by a 27-h.p. motor.

With three bridges in operation this dock has unloaded boats containing 10,500 tons of coal in 18 hours and with four bridges in operation has unloaded a similar quantity in 13 hours.

No trouble of a serious nature has developed in three years' operation and the manufacturers of this equipment and the owners of the dock are satisfied with the results obtained. The dock was extended from 1200 to 2600 ft. in length this spring and some trouble was experienced due to excessive drop in voltage at the further end. This has been taken care of by moving one of the 500-kw. transformers to the lower end of the dock and running an underground 13,000-volt circuit to this point.

Cable Car. This installation consists of an elevated railway on which are mounted the hoisting towers and tracks for cars. The following apparatus is on the dock proper: screening pockets, unloading pockets, traveling bridge, conveyor belts, car loaders, and box car loaders.

Energy is delivered to this dock at 13,000 volts, three-phase, 25 cycles, and is reduced to 440 volts by means of three 500-kw., three-phase transformers. The energy is delivered to the hoisting towers and traveling bridge by means of trolley wires.

The boats at these docks are moored at the end of the dock. As shown in Fig. 3, there are three hoisting towers with swinging booms. These booms are swung over the boat, and buckets take the coal from the boat and empty it into a hopper. From the hopper it is loaded automatically into cars and these cars, operated by cables, empty the coal into loading pockets; or if the coal is to be stored, the cars are shunted on the traveling bridge and load directly onto the storage pile. In taking coal from the storage pile shovel buckets are used and these empty the coal into the loading pockets.

The hoisting towers are equipped with clam shell buckets weighing 6,800 lbs. and holding two tons of coal. There is a counter-weight on these buckets weighing five tons. The motors are 200-h.p. wound rotor, 440-volt, three-phase, 25-cycle. The hoisting speed is 600 ft. per min. The control is pneumatic and small air compressors are mounted on each tower. The braking is by friction and asbestos shoes are used, the levers from the brakes being controlled directly by the operator. These buckets average 144 round trips per hour and three towers have unloaded an 11,246-ton boat in 18 hours. This type of tower has usually been installed with steam operated hoists and the manufacturers have claimed that the steam hoists were quicker. There are two other docks at this port using steam hoists of this type but neither of them has been able to do as rapid work as the electrically operated hoists.

The cable cars are 11 ft. long 5 ft. wide and 6 ft. high, and each holds four tons of coal. These cars pass under each hoisting tower and touch a lever which releases enough coal to fill the car one-third full. One 75-h.p. motor is used for operating the cables.

The screening and loading pockets are along the railroad tracks at one side of the dock and directly under the elevated cars. The loading pockets load directly into the cars by gravity. The screening pockets empty the coal into the cars after it has passed over the screens. The screenings fall on conveyor belts and are carried to the upper end of the dock and there emptied on to the screenings pile. One end of the moving bridge is connected to the elevated structure and the other rests on long legs, running on a track at the other side of the dock. The bridge is equipped with a loop track and in storing coal these tracks are connected to the elevated structure by switches and the bridge is moved along the dock as soon as one section is full. In loading coal from the dock two shovel buckets are used. These buckets hold two tons and empty the coal directly into the screening and loading pockets or into the cars, which in turn empty into the pockets. Wound rotor motors of 150 h.p. capacity are used to operate these buckets.

The conveyor belts for the screenings are 24 in. wide and are operated by 25-h.p. motors. They operate at 450 ft. per minute and carry 100 tons of coal per hour.

For setting cars a cable is run along the railroad tracks and is operated by a 32-h.p. motor. The box-car loaders are similar to the ones described under "Bridge Tramway."

This type of equipment has been very satisfactory and the only trouble experienced has been with the air control freezing in winter, due to moisture collecting in the pipes, and some trouble with the motors on the hoisting towers.

The vibration on the towers is so great that it is hard to brace the end connections of the stator windings so that they do not rub against each other and wear the insulation. It has been necessary to rewind the motors twice but it is thought that these are now braced securely enough to give no further trouble.

Man Trolley. The two types of equipment described above are adaptations of steam operated rigs to the use of electricity. The man trolley equipment is an effort to devise something particularly fitted to the use of electric motors. It is, in its simplest form, a traveling crane on legs but using a bucket instead of a hook.

There are in use here at the present time two types. One uses a hoisting speed of 300 ft. per minute and a trolleying or racking speed of 1,000 ft. per minute; the other uses a hoisting speed of 250 ft. per minute and a racking speed of 1,200 ft. per minute. Fig. 3 shows the first type of dock.

method will probably be devised for disposing of the screenings.

The car pullers and box car loaders have been described before.

The second type of man trolley equipment is shown in Fig. 1. This type is equipped with clam shell buckets weighing 7½ tons, while the total weight of moving equipment is 40 tons.

The energy is delivered to the transformer house, at 13,000 volts, three-phase, and is reduced to 440 volts by three 500-kw., single-phase transformers. The current is distributed to the bridges by three conductors running on the rear elevated stationary leg. Each hoist is equipped with one 225-h.p., three-phase, 25-cycle wound rotor motor for closing and hoisting the bucket, and two 112-h.p. motors for racking.

Fig. 1. Man Trolley.

The equipment consists of traveling bridges, screening hoppers, car pullers, and box-car loaders.

The energy is delivered at 13,000 volts, three-phase, 25 cycles to the junction house, shown in Fig. 2, which contains oil switches, meters and lightning arresters. From this junction house the current is carried to 13,000-volt, three-phase catenary trolleys running the whole length of the dock. The transformers for reducing the pressure to 440 volts are located in the cabin at the top of each bridge. The 440-volt trolley for the box car loaders receives its energy from the transformers on the bridges. The machine shop and car pullers receive their 440-volt energy from a transformer located in the junction house. The boats are moored at the unloading side of the dock. The buckets empty the coal from the boat into the front hoppers if the coal is to go out unscreened, and into the rear hoppers if it is to be screened. In case the coal is to be stored the buckets empty directly on the storage pile.

The buckets are of the clam shell type, weighing eight tons and carrying five tons of coal; the moving equipment, hoist, cab, air compressor, etc., weigh approximately fifty tons. Each hoist is equipped with two 150-h.p., three-phase, 440-volt, 25-cycle wound rotor motors. Both motors are geared together and used for opening and closing bucket and for hoisting. For raising and lowering the boom one 30-h.p. motor is used. For moving the bridge along the dock one 75-h.p. motor in front, and two 40-h.p. motors in back are placed at the bottom of each leg. These bridges are guaranteed to make 50 round trips per hour from the hold of the boat to the storage pile. When "breaking down" a boat one of these bridges has made eighty trips and unloaded 400 tons of coal in one hour.

The control system is direct current magnetic, actuated by air. The direct current is furnished by small motor generator sets, and the air by small air compressors in each cab.

Both pneumatic and dynamic braking are used. In dynamic braking direct current from the motor-generator sets is connected to the armatures of the hoist motors with the secondaries short-circuited through resistance. This type of braking is satisfactory but requires the use of a considerable amount of additional energy.

The screening hoppers at the rear of the dock, shown in Fig. 2, empty the screenings on to the rear end of the storage pile, which is inconvenient, and some other

The control is alternating current magnetic, and has thus far operated with no trouble at all. The braking is friction operated by foot levers.

The first type of man trolley equipment has been in use about two years and, while considerable trouble was experienced at first, the difficulties are being overcome and satisfactory results are now assured.

The second type of man trolley equipment has been in operation only about six months so that definite conclusions as to its results cannot be drawn at this time.

Summary of Coal Docks.

A comparison of the different types is shown in the accompanying table. While a larger number of cable car bridges are in use, these bridges are of a smaller capacity and not as much coal is handled by them.

The kilowatt-hour figures per ton of coal are approximate only, as these are liable to variation from time to time, due to the way the coal is handled. At times a larger proportion is screened than at others; also in case of fire in a coal pile it is necessary to dig out all the coal near the affected area, which increases the kilowatt-hour consumption materially.

The friction type of brake is the most reliable and economical. Dynamic braking is more expensive to operate but is satisfactory with trained operators. The operators have also tried connecting the motors directly to the alternating current line and using regenerative braking, but the drop of the bucket is too short to get satisfactory results. The alternating current magnetic control gives the least trouble and is the simplest to operate and maintain.

The load factor varies on the different types, partly on account of the different equipment and partly due to the methods of handling coal on the different docks.

The 440-volt distribution is the most satisfactory from an operating standpoint for both the coal dock and central station.

The copper for distribution is a little more expensive in the 440-volt distribution. The 13,000-volt distribution, while cheaper in first cost, has given trouble due to coal dust and smoke and steam from the locomotives collecting on insulators and in wet weather causing flash overs.

The above figures are for handling bituminous coal. Anthracite coal is hoisted from boats by the same equipment and is carried into sheds by means of conveyor, belts, etc., and so does not represent a radical departure from the usual conveyor systems.

The curves in Figs. 4, 5, 6, 7 and 8 were taken with a curve drawing wattmeter speeded up to give two inches per minute. The highest point on these curves is liable to an error of from four to six per cent, due to overshooting on the part of the pen, but they are sufficiently accurate to give comparative cycles of operation for the different types of equipment.

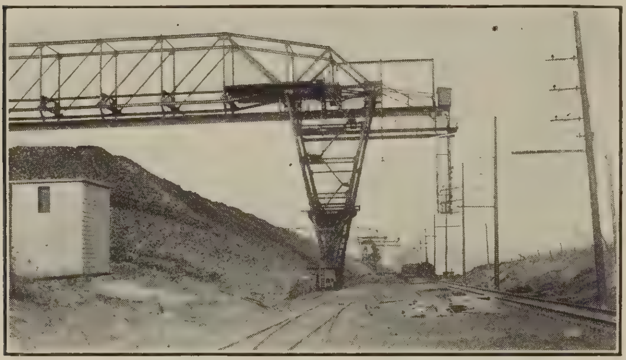

Fig. 2. End of Man Trolley Showing 13,000 Volt Catenary, 440 Volt Trolley.

In Figs. 4 and 8, the first type of cable-operated equipment and second type of man trolley equipment, the highest peak occurs while racking, while in the other types, as shown in Figs. 5, 6 and 7, the highest peak occurs while hoisting. The load factor is so low on the coal dock load that it is important to consider the peak, either when buying power or when generating it with the company's own plants. The most advantageous design from an economical and operating standpoint would be to have the hoisting and racking peaks the same.

In the above curves it will be noted that the extreme peaks are due to the acceleration of the motors and equipment and that the actual peak, once the machinery is in motion, is 50 to 60 per cent of the above figures.

Motors for use on the above work should therefore be designed for a low accelerating current and high starting torque and be especially well braced, as the excessive vibration on these towers is very severe on all the machinery.

It would be possible to design a dock with lower hoisting speeds, racking speeds, etc., which would handle the same amount of coal in a year and use current more economically, but it is necessary to unload large amounts of coal on short notice, as certain kinds of coal have a very limited movement to the lake ports and at other times, due to congestion on account of storms, etc., a large number of boats are at this port awaiting dispatch.

During the winter months, when coal is shipped out only, the loading facilities are able to take care of from two to four times the number of cars the railroads can supply, and with smaller equipment for loading, such as is provided at the dock using cable-operated equipment, the kilowatt-hour consumption per ton of coal, and also the peak, is materially reduced.

One of the local coal companies operates two docks, one equipped with direct-current motors driven from its own plant, the other operated by alternating-current motors and purchased energy. The company expresses itself as seeing no difference in operating between the two methods.

In connection with its own direct-current plant it has a storage battery installed for taking care of the peaks. This year it became necessary to increase its power facilities and the following conditions were considered:

Synchronous converter using purchased energy.

Induction motor generator set using purchased energy.

Additional steam-driven units.

Low pressure turbines using exhaust from present engines.

Additional storage batteries.

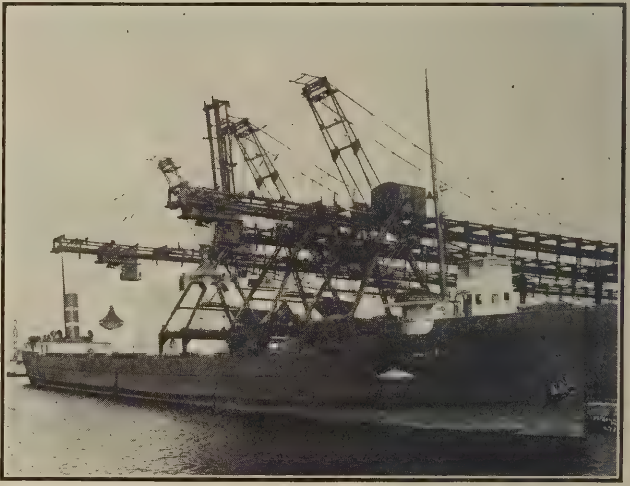

Fig. 3. Man Trolley Showing Bridge Unloading from Boats.

The requirements were that the additional units must operate in parallel with the present steam driven units.

The synchronous converter using purchased energy was finally decided upon, principally on account of its low first cost and the guarantee by the manufacturer of satisfactory operation. This machine was installed last summer and has worked satisfactorily and is taking care of the peaks and relieving the engines and storage batteries from the resultant shocks, so that a decrease in maintenance cost has already been noticed. The synchronous converter is compound wound without interpoles and is run with full series field. It is placed about 150 ft. from the main switchboard and each side is connected to the main bus by two 1,000,000-cir. mil cables. By using one or both cables it is possible to have the converter take a smaller or larger amount of the total load.

COMPARATIVE TABLE OF THE DIFFERENT TYPES.

Types of Equipment	No. rigs in operation	Inst. peak per ton of coal	Peak occurs while	Kw-hr. per ton of coal	Braking	Control System	Distribution System	Yearly kw-hr.	Yearly l.f. on inst. peak
Cable operated	3	119	Racking	1 09	Friction	A.C. magnetic	440 volts	980,000	8 %
Cable operated	1	129	Hoisting						
Car system	9	90	Hoisting	1 38	Friction	A.C. pneumatic	440 volts	71,424	4½%
Man trolley No. 1	6	97	Hoisting	1 76	Pneumatic	D.C. pneumatic	13,000 volts	3,258,220	6 %
Man trolley No. 2	3	85	Racking	1 50	Friction	A.C. magnetic	440 volts	1,200,000	12 %

Rates.

The rates charged for coal dock service are as follows: $1.00 per month for each kilowatt of the minimum rating of the load, or "reservation charge."

$.011 per kilowatt-hour for all power used up to 70 kw.-hr. for each kilowatt of rating of the load for the month for which charge is made.

$.005 for all additional power used, or "consumption charges."

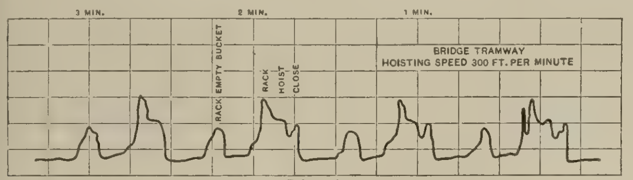

Fig. 4.

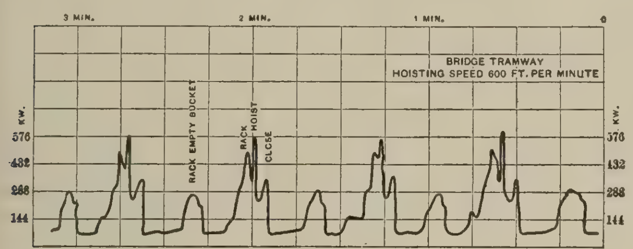

Fig. 5.

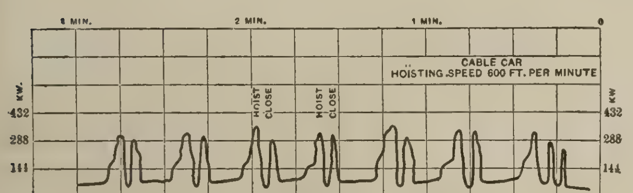

Fig. 6.

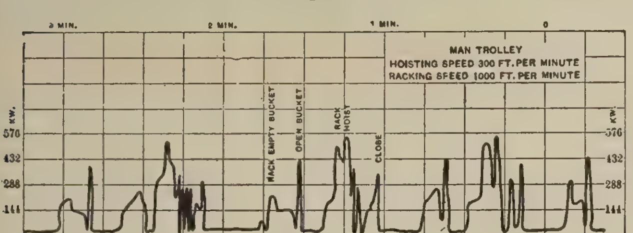

Fig. 7.

The minimum rating of the load is the maximum rate at which power is used, as determined by curve-drawing meters, on the basis of the highest amount obtained from any of the following measurements:

The maximum instantaneous peak less 60 per cent discount.

The maximum one-minute peak less 50 per cent discount.

The maximum three-minute peak less 33 1-3 per cent discount.

The maximum five-minute peak less no discount.

The minimum rating thus obtained is used until succeeded by a greater peak and such increased minimum rating holds until a still greater peak is obtained, and so on during the life of the contract.

A curve-drawing wattmeter is installed at each dock for obtaining the peak and watt-hour meter for obtaining the kilowatt hour consumption.

In coal dock service, the highest peak obtained is the maximum instantaneous peak, less 60 per cent discount, and this peak is used in determining the "reservation charge" for this class of service.

This method of charging gives a net kilowatt-hour rate varying according to the load factor, as shown in Fig. 10.

It would naturally be assumed that with a peak method of charge some form of flywheel equalizer would be installed at some of the docks. Owing to the sixty per cent discount from the maximum peak the installation of a flywheel does not offer sufficient saving to warrant the expenditure of a large sum of money for this purpose.

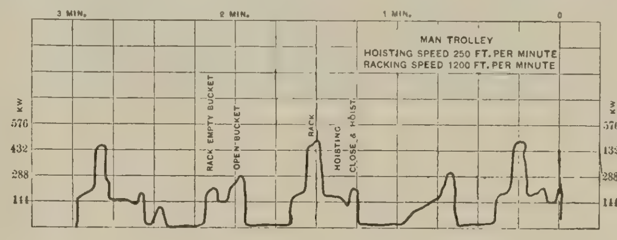

Fig. 8.

Operation from Central Station.

The power station is equipped with 7,500-kw. generators driven by 13,000-h.p. turbines under a head of 375 ft. The turbines are fed by 7 ft. pipes, approximately 5,000 ft. long, and a standpipe is located at the lower end of the pipe line to each pipe. Oil pressure governors and mechanically operated relief valves are installed.

With all the coal docks in operation together with the other miscellaneous load, instantaneous load changes of 5,000 kw. have been noted at the power station. With two units in operation no trouble is experienced with speed regulation, but with one unit only, the peaks cause

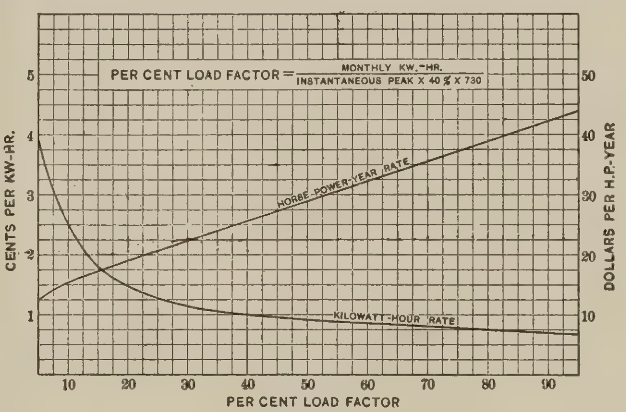

Fig. 9.

hunting of the governor and a resultant variation of frequency of 4 per cent either side of normal has been noted.

The coal docks using the 13,000-volt catenary trolley have occasioned some trouble to the underground cable system and substation oil switches, due to short circuits. The resultant surge affects the entire distributing system owing to the sluggishness of the dock switch.

For this reason all the coal docks with this type of distribution have been placed on the same feeder and it is expected that the installation of a different type of oil switch with either a time limit relay or reactance in the trolley connections at each dock will entirely do away with this trouble.

After three years of operation the use of alternating current for this class of service has proved commercially successful and it is safe to say that the majority of new installations at this point will be of this character.

THE BATTERY TRUCK CRANE.

A bulletin recently issued by the General Electric Company shows many examples of the application of this new and very useful device. This truck crane should find a wide application in and about Railroad shops and yards. The truck is extremely useful as a traction engine for hauling trailers containing freight.

SHOP SECTION
EDITED BY
GEO. W. CRAVENS

Shop Series No. 12

COLLINWOOD SHOPS OF THE L.S. & M. S. RAILWAY

The principal shops of the Lake Shore and Michigan Southern Railway are located at Collinwood, Ohio, and were erected in 1902. They consist of nine large main buildings, an office building and a number of smaller buildings and sheds and a locomotive round-house. The arrangement is both compact and logical, the power plant being in the center of the group, with the locomotive machine shop and blacksmith nearby. The main storehouse is also near the center of the group and between the locomotive shop and the car shops. The two transfer tables are between the three car shops buildings, all of which are at right angles to the locomotive shop, and the wood working mill and new freight car repair shop are next north of the group. The new freight car repair shop is not labeled on the plan of the layout herewith, but is shown as a large building next to the wood working mill.

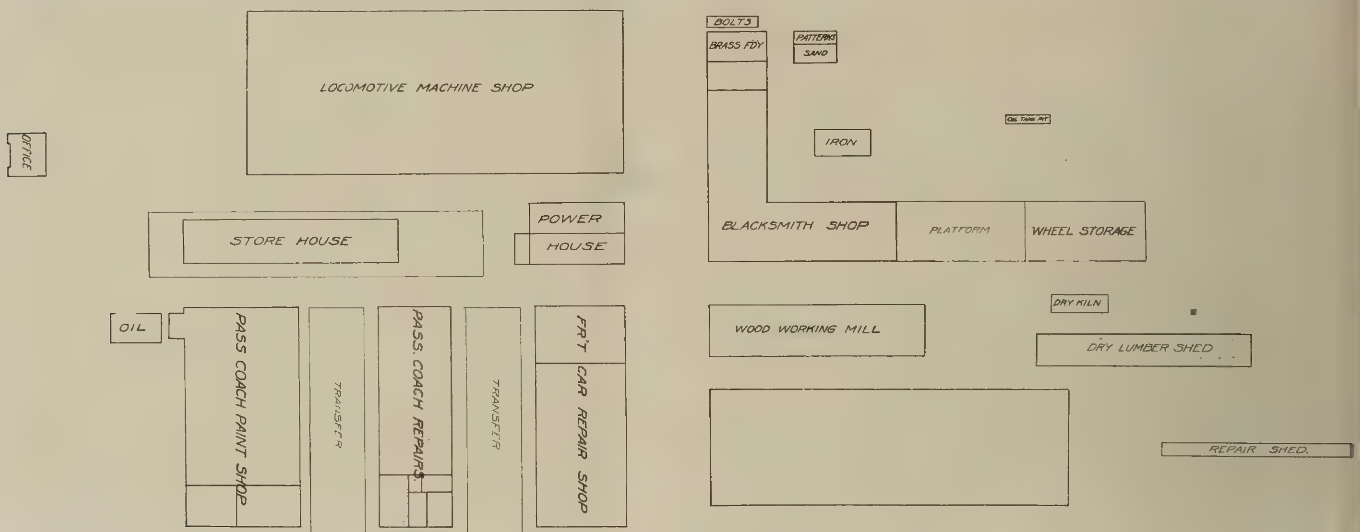

Fig. 1. General Plan of Shop.

Power House and Distribution System.

The power plant is located in a brick building 85 ft. by 132 ft. which is divided into the usual two sections, boiler room and engine room, each occupying about one-half the building. In the boiler room are 8 Babcock and Wilcox water tube boilers of 300 h.p. each, all but one of which are equipped with chain grate stokers. Each pair of boilers is equipped with a 60-inch steel stack 150 ft. high and has an ash pit below. All coal and ashes are handled by a conveyor, and a coal crusher is provided for breaking up the coal into sizes suitable for use with the stokers.

The pumps are also located in the boiler room and extension and comprise a Worthington 12 in. x 17 in. x 3½ in. x 15 in. compound hydraulic pump, providing a pressure of 1500 lbs. per sq. in., an accumulator therefor, two Underwriter's fire pumps, each 8 in. x 10 in. x 12 in., and supplying 1000 gals. per minute each, two duplex boiler feed pumps, also a Cochrane feed water heater and receiver.

In the engine room are two 400 kw., 240-volt, Crocker-Wheeler d. c. generators direct connected to 650 h.p. horizontal cross compound Buckeye engines, one 300 kw., 240-volt, Crocker-Wheeler dc. generator direct connected to a 500 h.p., vertical cross compound Buckeye engine, a motor generator set consisting of a 240-volt motor coupled to a 40-kw., 500-volt dc. generator and a balancing rotary transformer for multiple voltage system. The 500-volt generator is to supply current for the 3 locomotives used in making up trains on the gravity incline.

There are also two Franklin air compressors of 300 h.p. each in the engine room, 31 in. and 20 in., 27 in. and 16½ in. x 24 in., driven by horizontal cross compound engines and delivering 1500 cu. ft. of air per minute compressed to 100 lbs. per sq. in. There is also an air pump at the round house pumping into this same line. The crane in the engine room is a 15-ton Browning Engineering Co.'s electric crane with chain hoist.

A feature of this engine room is the gravity oiling system which was installed by the company's own engineers. This consists of a 200-gal. tank mounted 30 ft. above the floor, from which the oil is piped to every bearing. After passing through the bearings the oil is caught, separated, filtered and returned to the tank by compressed air periodically for further use.

The distribution system is entirely under ground in 5 ft. tunnels running from the power plant to all of the principal buildings, these tunnels also carrying the heating and air pipes and being very well lighted electrically. All power is generated at 240 volts, excepting the small amount at 500 volts previously mentioned, and is continuous current. It is then transformed to multiple voltages for distribution and use through the shops. These voltages are 40, 80, 120, 160, 200, 240 volts and are used to vary the speeds of the motors by means of controllers which insert resistance in 12 steps between each change of voltage. In this way an enormous variation in speeds is obtained, although it is done at the expense of considerable complication in the controllers. It also de-

mands motors of sufficient size to deliver full load at the lowest voltage and speed in most cases.

Locomotive Machine Shop.

The locomotive machine shop occupies the largest building at this plant, it being 248 ft. by 530 ft. It is divided into three sections, respectively 69½, 100 and 78½ ft. wide, the center one of which is lower and contains the machine shops. These are arranged so that the heavy machinery is in the side next to the locomotive erecting shop and the light section next the boiler and tank shop. The roof of the 100 ft. central section is practically all skylight, which makes it a bright machine shop. The 24 pits in the erecting bay run at right angles to the main aisle and are each 38 ft. long, the tracks in the tank shop being also at right angle. All machine tools in this shop have individual motor drives except those in the tool and brass rooms.

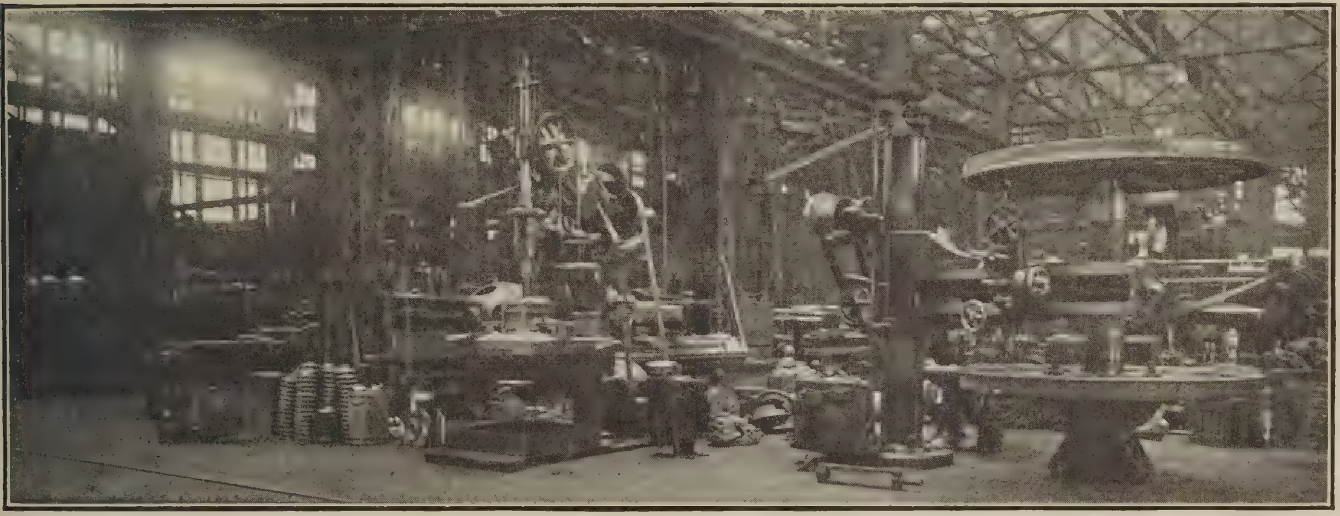

Fig. 2. Interior of Locomotive Machine Shop.

In the machinery bay, over the heavy tools, is a 7½ ton Niles crane of 47 ft. span located 17 ft., 3 in., clear, above floor with three Crocker-Wheeler motors on the trolleys. These are arranged as follows: 20 h.p. bridge, 20 h.p. hoist and 2½ h.p. cross travel. Over the erecting bay there are two Niles cranes, one of 100 tons capacity and 65 ft., 6 in. span located 37 ft. above floor and one of 10 tons capacity and 63 ft. span 25 ft. above floor. The 100 ton crane has the following Crocker-Wheeler motors: Two trolleys 45 h.p. each, bridge 45 h.p., and two cross traversing 10 h.p. each. The 10 ton crane has three motors; also, 20 h.p. bridge, 20 h.p. hoist and 2½ h.p. trolley. In the boiler and tank shop section there is a 30-ton Niles crane of 74 ft., 6 in. span with five motors. It is located 32 ft., 9 in. in the clear above the floor, and the motors are of the following sizes: Two trolleys 2½ h.p. each, bridge 30 h.p. and two hoists 20 h.p. each. All of the cranes in this building are equipped with General Electric Co.'s controllers.

In addition to the main overhead cranes there are several smaller cranes around the shop, both electric and air operated. A group of five lathes and a planer are served by a 1-ton electric crane containing two 3-h.p. and one 1½-h.p. motor, and a similar crane serves the connecting rod assembling floor. Numerous air operated gib cranes are also used here. A complete list of the motors and machine tools is given herewith.

Freight and Passenger Car Shops.

The three older car shops are all 336 ft. long with widths of 160 ft. for the passenger coach paint shop, 110 ft. for passenger coach repair shop and 125 ft. for the old freight car repair shop. Two 70 ft. transfer tables run between these three buildings. The new freight car repair shop is located to the north-east of the old buildings and is 160 ft. wide by 500 ft. long, access being by means of 8 tracks running full length. Five truck tracks are also placed between the main tracks for convenience in handling material.

The car machine shops are unusually well equipped, most of the machine tools having individual drives with a few small groups, such as drill presses, pipe machinery, grinders, etc. The lights in these shops are nearly all 100 watt tungsten lamps with porcelain enameled steel reflectors 18 in. in diameter, each lamp having its own pendant push button switch. There are 60 Cooper-Hewitt mercury vapor lamps in the new freight car repair shops, not shown in list.

Blacksmith Shop and Foundry.

A large L-shaped building near the locomotive shop contains both the smith shop and brass foundry. This building is 85 ft. wide in both wings and is 320 ft. long one way by 265 ft. long the other way. The brass foundry is at the end of the long wing and is 40 ft. by 84 ft. inside and contains five furnaces. The bolt shop is next, separated by a brick wall, and is 38 ft. by 84 ft. inside. Another brick wall separates this from the main smith shop, and just next to this wall is located the spring shop.

The steam hammers occupy the entire remaining portion of this wing and are arranged in two rows with the furnaces at the end of the room. The other wing is given over to the balance of the tools and equipment. A wide skylight runs nearly full length of the shop with louvre ventilator along the center.

Extending beyond the northerly end of the short wing of the blacksmith shop is a storage platform 85 ft. wide by 300 ft. long, of which the outer 140 ft. are devoted to wheel storage. A single track runs full length down the center with spur tracks cross wise at the end for wheels. The iron rack and platform are placed in the angle of the L and are very conveniently accessible. The scrap platform, 35 ft. by 445 ft., is also placed next to the smith shop near the iron rack.

Wood Working Mill.

A building 70 ft. wide by 300 ft. long, placed between the new freight car shop and the blacksmith shop, contains the wood mill. All of the wood working machines here have individual motors drives, the motors ranging in size from 5 h.p. to 60 h.p. There are shaving fan exhausters here ranging from 35in. to 70 in. and driven by motors of from 10 h.p. to 60 h.p. in capacity. The two hollow chisel mortisers each contain two motors, one 15 h.p. and one 5 h.p., all other tools having single motors.

Round House and Stores.

The round house or locomitive terminal is at the southerly end of the yards and contains 35 stalls. A small but well equipped machine shop adjoins this round house in a building 58 ft. wide by 173 ft. long and is invaluable for making light or running repairs. The auxiliary adjuncts are in duplicate, these comprising two coal chutes, two sand bins, two long ash pits and two short ash pits, the latter being equipped with pneumatic ash handling devices.

The power circuit to the round house is placed underground and is fireproof and in duplicate, that to the turn table being also in duplicate to insure getting locomotives out in case of fire. Most of the tools in this machine shop are driven as one group by a 25 h.p. motor with a single 10 h.p. motor on the 36 in.-60 in. extension gap lathe and a 20h.p. motor on the turn table. Lighting is by A-B regenerative flame arcs.

The general storehouse is 60 ft. by 302 ft. and stands between the locomotive shop and the car shops, where it is most convenient of access. It is two stories high and entirely surrounded by a platform, a portion of which is used for castings storage. The most noteworthy feature of this storehouse is the great care taken to have everything neatly and conveniently arranged, bins being provided for all small parts and the balance being placed in carefully arranged piles. Ample aisle space for trucking is allowed and a large number of arc lamps and 100 watt tungstens are hung for light.

Yards and Lighting.

In general, the yards are well laid out for convenience in handling material and all buildings are served by one or more tracks of standard gauge, connecting with the main system. A turntable is located just outside the locomotive machine shop for convenience in reversing locomotives and several small turntables are placed at junction points within the buildings for turning trucks. The general material yard is large and is floored with wood for ease in trucking and to protect the lumber and other material from dirt.

The dry kiln and the lumber shed are placed near the wood working mill and car shops, the dry lumber shed being 45 ft. wide by 300 ft. long with a track down the center. Three electric locomotives operate in the yards, each being equipped with a 25h.p. motor. There are a total of 23 motors scattered about the yards and small buildings aggregating 420 h.p. in adition to a 3¾ kw. lifting magnet.

The two yard cranes are of 20 tons capacity each, one being equipped with five motors as follows: Two 2½ h.p., two 21 h.p. and one 42 h.p., and the other also having 5 motors as follows: Two of 3 h.p., two of 30 h.p. and one of 35 h.p. Provision is also made for a yard crane of about 115 ft. span over the storage yard along the center of the main group of buildings. The transfer tables are each equipped with a 25 h.p. motor and the turntable back of the big shop has a 20 h.p. motor.

The shop lighting has been largely by means of enclosed arc lamps, mostly Ft. Wayne and A-B regenerative flame arc lamps, but the present tendency is to use tungsten lamps of high wattage, singly and in clusters. The accompanying table gives a summary of the lighting, but certain features are worthy of special mention. For instance, flaming arc lamps have been placed 25 ft. above the floor in the shops, with other arc lamps 15 ft. high. This gives excellent results. A small platform runs full length of the locomotive machine shop up in the roof trusses for convenience in trimming and 8 A-B regenerative flame arc lamps in deep reflectors are placed 50 ft. above the floor in the locomotive erecting shop and give fine lighting effect.

Miscellaneous.

A feature not usually found in railway shops is the sewage disposal plant. This is located west of the locomotive machine shop and was made necessary by local conditions. The office building is at the southerly side of the main group of buildings and contains the offices of the principal shop officials.

The yards are lighted by arc lamps placed at frequent intervals along the walls of the buildings and on poles, and fire hydrants are freely scattered throughout the yards. All motors for group drives are mounted on the bottom chords of the floor trusses with a permanent iron ladder to each motor. This is a very good but unusual arrangement and should prove very valuable to others who may adopt it.

The buildings are heated by hot air supplied over steam coils and forced in by engine driven Buffalo blowers. These are placed as follows:—two of 25 h.p. each in locomotive machine shop, one in paint shop, one in forge shop, one in car machine shop and one in the storehouse. The freight car repair shop also contains a vacuum heating system.

Tunnels for distributing power in various forms, whether electric, steam, compressed air or water under high pressure are becoming more common in railway shops, and soon justify the first cost by the saving in operating expense. These shops are so equipped and the tunnels are lighted with incandescent lamps throughout. This makes it unnecessary for the maintenance men to bother with lanterns and allows frequent and easy inspection, which means that it is more likely to be done.

In conclusion, the writer desires to extend his sincere thanks to Mr. H. C. Meloy, Chief Electrican of the L. S. & M. S. Ry. for his hearty co-operation and assistance in getting together the material for this article.

SHOP LIGHTING.

Building	Arc Lamp	Incandescent Lamps Number 16 C.P.	Tungsten No.	Tungsten Watts	Extension Receptacles
Storehouse	16		90	100	
Power House	10	196			
Office Bldg.	3	64	60	60	
Transfer House	24	46			
Ice House	8	20			
Brass Foundry	6	28			
Bolt Shop	6				
Scrap Platform	8				
Blacksmith Shop	12	16	20	100	
Old Car Shop		179	20	100	
New Car Shop		68	30	100	
Wood Working Mill	12	48			
Tank and Cab Shop	32	118			
Buffing Room	4				
Upholstering Room			13	60	
Trimming Room			5	150	
Varnishing Room			20	60	
Paint Shop	40	58			230
Coach Shop	28	179			
Truck Shop	28				
Lumber Yard	6				
Gravity Tracks	30				
Roundhouse	53	140			
Nottingham Shop	6	40			
Roundhouse Mach. Shop	6				
Tin Shop		10			
Air Brake Room			9	150	
Locomotive Shop	22	168			251
Caboose Shop		57			
Yard Office		64			
Rip Tracks		36			
Boiler Shop	6	20			48
Laboratory		20	32	100	

List of Tools and Motors

LOCOMOTIVE MACHINE SHOP.

Description of Tool Operated.	H.P.
51″ Boring Mill	7½
84″ Quartering Machine	5
	5
84″ Boring and Turning Mill	15
42″ Car Wheel Borer	10
28″x48″ Extension Gap Lathe	7½
84″ Wheel Press, 300 tons	10
28″ Engine Lathe	10
16″ Slotter	10
84″ Driving Wheel Lathe	15

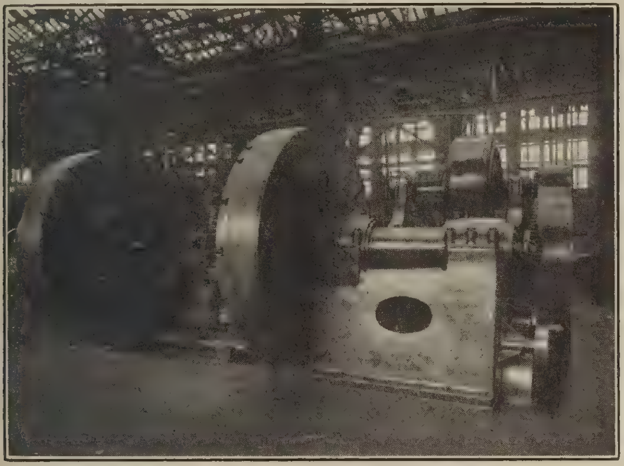

Fig. 3. Large Engine Wheel Lathe.

Description of Tool Operated.	H.P.
37″ Boring Mill	7½
30″ Engine Lathe	15
36″ Engine Lathe	7½
No. 4 Plain Milling Machine	20
30″ Engine Lathe	10
Loco. Rod Boring Machine	7½
No. 3 Vert. Spindle Milling Machine	10
No. 4 Plain Milling Machine	15
Cold Saw	4.7
36″ Engine Lathe	10
24″ Turret Lathe (See also Motor No. 273)	10
37″ Boring Mill	7½
54″ Planer	20
Frame Slotter	20
6′ Radial Drill	5
No. 5 Vertical Drill	10
60″ Horiz. Boring & Milling Machine	5
32″ Engine Lathe	10
100″ Boring Mill (See also Motor No. 46)	35
28″ Engine Lathe	7½
No. 5 Drill Press	7½
2 spdl. Sensitive Drill	
28″ Engine Lathe	7½
24″ Planer	15
18″ Norton Grinder	10
42″ Planer	15
Portable Valve Setting Machine	3
100″ Boring Mill (See also Motor No. 37)	5
Twist Drill Grinder	17.5
18″ Emery Grinder	3.1
36″ Planer	15
Driving Axle Lathe	10
36″ Open Side Planer	15
18″ Slotter	7½
Description of Tool Operated.	H.P.
90″ Driving Wheel Lathe	5
	50
24″ Geared Slotter	15
No. 3 Hollow Hex. Turret Lathe	15
Oscillating Surface Grinder	7½
32″ Standard Drill Press	7½
84″ Driving Wheel Lathe	25
24″ Back Geared Crank Shaper	
No. 5 Vertical Drill Press	
16x6′ Bed Engine Lathe	
16″x6′ Bed Engine Lathe	
21″x10′ Bed Engine Lathe	
21″x10′ Bed Engine Lathe	
21″x10′ Bed Engine Lathe	
No. 2 Plain Milling Machine	
Grindstone	
Buffing Wheel	
Polishing Machine	
Link Pin Grinding Machine	
32″ Engine Lathe	10
24″ Shaper	25
Twist Drill Grinder	15
No. 2 Cabinet Turret Lathe	25
No. 2 Cabinet Lathe	35
16″ Slotter	20
48″ Radial Drill	5
7½ ton Crane	20
	20
	2½
1 ton Crane	3
	3
	1.5
1 ton Crane	3
	3
	1.5
18″ Emery Grinder	3
24″ Turret Lathe (See also Motor No. 29)	0½
72″ Gap Shear	10
72″ Gap Punch	10
36″ Vertical Lathe	7.5
6′ Radial Drill	10
No. 4 Universal Miller	
2 spdl.. Sensitive Drill	
20″ Back Geared Crank Shaper	
37″ Boring Mill	
32″ Standard Drill Press	
Seat Grinder	
16″ Engine Lathe	
16″ Engine Lathe	
24″ Engine Lathe	
24″ Engine Lathe	
3″ Pipe Cutting Machine	
6″ Pipe Threading Machine	
No. 2 Cabinet Turret Lathe	
Emery Grinder	15

LOCOMOTIVE ERECTING SHOP.

Description of Tool Operated.	H.P.
Portable Valve Setting Machine	3
18″ Emery Grinder	3.1
18″ Emery Grinder	3.1
18″ Emery Grinder	3.1
18″ Emery Grinder	5
Spring Testing Machine	6.5
45″ Smoke Exhauster	25
Portable Valve Setting Machine	3
Hollow Hex. Turret Lathe	5
Portable 18″ Engine Lathe	3
Portable 2 spdl. Positive Drill	0½
100 ton Crane	45
100 ton Crane	45
100 ton Crane	45
100 ton Crane	10
100 ton Crane	10

10 ton Crane	20
	20
	2½
Lagging Pulverizer	5
Extra Motor for Crane No. 552	45

LOCOMOTIVE BOILER SHOP.

Description of Tool Operated.	H.P.
Flue Cutter	10
No. 4 36" Throat Shear	5
No. 2 Positive Pressure Blower	35
6' Straight Roll	10
No. 4 36" Throat Punch	3
No. 2 Plate Bending Rolls	10
Rotary Bevel Shear	10
No. 2 Shear, 48" Throat	5
No. 2 Punch, 48" Throat	5
4-spdl. Multiple Drill	10
No. 2 Radial Drill Press	3
12' Bending Rolls	20
	15
9" Horiz. Flanging Punch	5
42" Planer	20
Flue Cut-off Saw	7½
No. 2 Positive Pressure Blower	7½
36" Throat Multiple Punch	7½
30 ton Crane	20
	20
	30
	2½
	2½
Flue Rattler	35

LOCOMOTIVE BRASS FOUNDRY.

Description of Tool Operated.	H.P.
No. 2 Positive Pressure Blower	15
No. 2 Blower	10
Moulding Machine	6.5
No. 4 Plain Milling Machine	10
Volume Blower	5
6-Spindle Drill	15
No. 1 Brass Cinder Mill	10
34" Spur Geared Tumbling Barrel	15
Blower	15

LOCOMOTIVE SMITH SHOP & BOLT ROOM.

Tool No.	Description of Tool Operated.	H.P.	Type.	R.P.M.
147	2" Six Spindle Nut Tapper	20	CM	775
237	2" Triple Head Bolt Cutter			
238	1½" Triple Head Bolt Cutter			
239	1" Quad. Head Bolt Cutter			
240	1½" Quad. Head Bolt Cutter			
241	6 spdl. Nut Tapper			
242	6 spdl. Nut Tapper			
243	1½" Quad. Head Bolt Cutter			
277	200 lb. Compact Hammer	7½	CCM	875
86	Combined Punch and Shear	10	CCM	825
87	4" Bar Shear	15	CCM	800
68	No. 8 Bulldozer	25	CCM	750
290	No. 7 Pressure Blower	15	CM	800
67	No. 6 Bulldozer	20	CCM	775
1204	Ajax Forging Machine	15	CCM	800
66	2½" Bolt Header	15	CM	800
287	No. 11 Volume Blower	35	CM	700
288	110" Steel Plate Exhauster	25	CM	750
74	3" Bar Shear	10	CCM	850
1040	Grinder	3.1	CM	750
232	1½" Bolt Header	20	CM	775
283	No. 1 Positive Pressure Blower	9½	CM	1100
199	Combined Punch and Shear	15	CM	800
40	No. 5 Forging Machine	35	CCM	700
279	50 lb. Compact Hammer	5	CCM	1000
278	200 lb. Compact Hammer	7½	CCM	875
276	200 lb. Compact Hammer	7½	CM	875
275	200 lb. Compact Hammer	7½	CCM	950
1041	Emery Grinder	7½	CM	875
1143	No. 3 Blower	20	CM	775
281	No. 3 Positive Pressure Blower	10	CCM	850

LOCOMOTIVE SHOP LABORATORY.

Tool No.	Description of Tool Operated.	H.P.	Type.	R.P.M.
83	200,000 lb. Screw Test'g Mach.	7½	CCM	875
95	Vibratory	1.25	CMR	1250
		10	CM	825
207	No. 2 Power Hack Saw			
1011	12"x5' Engine Lathe			
1023	1000 lb. Testing Machine			
1030	24" Shaper			
1132	Horizontal Drill			
1133	Crusher			
1134	Emery Grinder			

CAR MACHINE SHOP.

Description of Tool Operated.	H.P.
30" Drill Press	6.5
42" Engine Lathe	7½
24" Back Geared Crank Shaper	7½
24" Engine Lathe	5
Double Head Axle Lathe	15
Double Head Axle Lathe	15
Double Head Axle Lathe	15
Driving Axle Lathe	10
No. 2 Double Car Wheel Press	10
	10
48" Car Wheel Borer	10
No. 2 Car Wheel Borer	10
No. 2 Car Wheel Borer	15
40" Car Wheel Lathe	15
1" Punch and Shear, 24" Throat	7½
7½" Throat Horizontal Punch	5
No. 2-A Cold Saw	5
No. 5-B Plain Horiz. Milling Machine	7½
16"x8' Engine Lathe	
Pipe Cutting Machine	
2" Pipe Threading Machine	
1-spdl. Sensitive Drill	
	5
Single Column Borer	
No. 4 Comb. Rip and Cross Cut Saw	
	10
30" Drill Press	
30" Drill Press	
30" Drill Press	
30" Drill Press	
30" Drill Press	
	15
Locomotive Frame Slotter	
Drill Grinder	
Water Tool Grinder	
	7½
51" Boring Mill	15
18" Emery Grinder	5
42" Pond Truck Wheel Lathe	
	40
	2
Driving Axle Lathe	2½

CAR CLEANING DEPARTMENT.

Description of Tool Operated.	H.P.
No. 4 Up-Blast Blower	
Hair Picker	
Hair Picking Machine	
	20

CAR CABINET SHOP.

Description of Tool Operated.	H.P.
4-spdl. Horizontal Boring Machine	15
7"x24" Surfacer	50
Exhaust Steam Fan	3
Oliver Jointer	0½
Jointer	0¾

CAR WOOD MILL.

Description of Tool Operated.	H.P.
4-sided Timber Planer	45
No. 4 Rip Saw	20
No. 4 Cut-off Saw	15
No. 27—6 Roll 4 Hd. Planer and Matcher	45
No. 6 Auto. Cut-off Saw	15
Hollow Chisel Mortiser	
	15
	5
42″ Band Saw	13
No. 327—5 spdl. Boring Machine	20
No. 70 Tenoner	7½
Jointer	7½
No. 5 Self Feed Rip Saw	20
No. 7 Hollow Chisel Mortiser and Borer	
	15
	5
3-spdl. Vertical Boring Machine	10
Gainer	15
No. 3 Rip Saw	45
No. 5 Vertical Cut-off Saw	20
Oliver Swing Cut-off Saw	10
No. 4 Vertical Tenoner	15
Inside Moulder	45
Automatic Saw	15
No. 3 Double Head Shaper	6.5
6″ Sticker	20
Combination Saw	13
24″ Single Surfacer	10
No. 2 Ex. Hvy. Auto. Car Gainer	15
70″ Shaving Fan Exhauster	60
60″ Shaving Fan Exhauster	35
40″ Shaving Fan Exhauster	15
35″ Shaving Fan Exhauster	10
45″ Shaving Fan Exhauster	20
55″ Shaving Fan Exhauster	25
20″ Wood Lathe	7½
Automatic Knife Grinder	7½
40″ Bevel Band Saw	13
No. 5 Universal Horiz. Tenoner	15

CAR UPHOLSTERING DEPARTMENT.

Tool No.	Description of Tool Operated.	H.P.
1137	Sewing Machine	
1138	Sewing Machine	
		1½

COACH DEPARTMENT.

Tool No.	Description of Tool Operated.	H.P.
491	Double Head Buffing Wheel	
490	Double Head Buffing Wheel	
489	Double Head Buffing Wheel	
488	Doublt Head Buffing Wheel	
		10
1039	Grinder	3.1

BUFFING ROOM CAR DEPARTMENT.

Description of Tool Operated.	H.P.
None. Nickel Plating Machine	6½
None. Nickel Plating Machine	400Kw.
None. Small Exhaust Fan	0½
None. Small Exhaust Fan	0½

CAR PAINT SHOP.

Tool No.	Description of Tool Operated.	H.P.
1344	Metallic Moulding Saw	0½
1345	Paint Mixer	1.5

CAR TRUCK SHOP.

Tool No.	Description of Tool Operated.	H.P.
1341	Jig Saw	0½

FREIGHT REPAIR SHOP.

Description of Tool Operated.	H.P.
Cut-off Saw	10
Vacuum Pump	
Vacuum Pump	
	7½
Group of Bench Buffing Wheels and Angle Cock Grinders in Air Brake Room	1.5

GENERAL STORE HOUSE.

Description of Tool Operated.	H.P.
Paper Cutter	1¼

COLLINWOOD TELEPHONE EXCHANGE.

Description of Tool Operated.	H.P.
Telephone Circuit	0½
Battery Ringing Circuit	½Kw.
Charging Batteries	6½

ENGINE HOUSE.

Description of Tool Operated.	H.P.
16″x6′ Bed Engine Lathe	
200 lb. Compact Hammer	
2½″x18″ Emery Grinder	
30″ Drill Press e	
50″ Drilling Machine	
1½″ Single Head Bolt Cutter	
24″ Shaper	
32″x32″x10′ Planer	
16″x8′ Bed Engine Lathe	
24″x14′ Bed Engine Lathe	
Driving Axle Lathe	
24″x14′ Bed Engine Lathe	
30″″ Blower	
	25
36″—60″ Extension Gap Lathe	10
Turntable	20

POWER HOUSE.

Description of Tool Operated.	H.P.
40 K. W. Generator (See No. 261 below)	35
Balancing Transformers	27Kw.
Balancing Transformers	27Kw.
Balancing Transformers	27Kw.
Cross Compound Steam Engine	400Kw.
Cross Compound Steam Engine	400Kw.
Vertical Engine	300Kw.
Link Belt Conveyor	10
Coal Crusher	20
35 H. P. Motor (See No. 206 above)	40Kw.

SHOP YARDS & MISCELLANEOUS PLACES.

Description of Tool Operated.	H.P.
Scrap Shear, on Scrap Dock	10
30″ Portable Swing Saw, in Wood Yard	20
Elevator, in Store House	15
Motor Car No. 5593	25
	2
Motor Car No. 5602	25
	2
Motor Car No. 5581	25
	2
Ice Crusher	25
20 ton Yard Crane	
	2½
	2½
	21
	42
	21
Turntable for Back Shop	20
20 ton Yard Crane	35
	30
	30
	3
	3
Transfer Table No. 1	25
Transfer Table No. 2	25
X-357	3¾Kw.

AMPERE HOUR METERS.

The Sangamo Electric Company, of Springfield, Ill., have just issued their Bulletin No. 19, describing ampere hour meters for use on vehicle battery charging service. Complete wiring diagrams for well-known types of vehicles are shown.

Lesson No. IV.

The Lead Storage Battery

Discharge. *(Continued)*

Batteries are usually rated on what is known as the 8 hour basis, and 40 amperes, then, is the normal discharge rate of the 320 ampere hour battery. If the battery is a 280 ampere hour capacity the normal current will be 1/8 of 280 or 35 amperes; and 240 ampere hour battery 30 amperes, etc. By speaking of an ampere hour we mean one ampere flowing for one hour, 10 ampere hours, 1 ampere for 10 hours, 10 amperes for 1 hour or 5 amperes for 2 hours, etc.

The size of every battery should be given on a card placed in the locker of a car on which it is located. If the battery is completely discharged it will be necessary to charge it at the normal rate for more than 8 hours to bring it back to full capacity, this excessive charge being necessary to make up for battery losses, leakage, etc.

Battery should never be discharged below 1.75 volts per cell. This is equal to 28 volts for 16 cells (32 volt system), 56 volts for 32 cells (64 volt system) and 94 volts for 54 cells (110 volt system). At this point the battery capacity is practically gone and if the battery is allowed to discharge below this point, it will be very apt to sulphate the plates.

Every car should be inspected for battery voltage on entering the yard, but the battery voltage alone means absolutely nothing unless you have all lights in the car turned on for at least one minute before you take the reading of battery voltage. The voltage should then be taken right at the battery terminals themselves so that an error of line loss up to the switch board will be eliminated.

Don't make the mistake of reading battery voltage on open circuit or with a low current flowing. Even a battery completely discharged may give a comparatively high voltage on open circuit.

Overcharge.

It is good for all batteries to have an overcharge of an hour every month or so, as this breaks up any white sulphate formed in the plates more effectively than an ordinary charge would. To give this monthly overcharge, the normal charge should be continued at the normal 8 hour rate until you get three consecutive half hour voltage readings of the same value, but be careful the battery doesn't overheat.

Automatic Control of Overcharge.

There are many devices such as stop charge relays used in connection with axle lighting systems, which, when the battery voltage reaches a certain value, will operate to stop the charging or reduce the charging current to a low value, giving what is known as the, "Taper charge." These, while they may operate for a time very satisfactorily must be carefully watched.

Of the two evils in battery operation, insufficient charge and destructive overcharging, the latter type is by far the more dangerous for the reason that it is much harder for a man that is not a battery expert to detect it. If you don't give the battery enough charge, you will very soon find it out, by failure of lights and by the plates turning gray which indicates the formation of white sulphate; but where the battery is being destructively overcharged it is almost impossible to detect the trouble. The plates have a *fine healthy color* —(too good a color, in fact) the positive, a rich chocolate brown and the negative a slate gray, so that the battery to all appearances is in fine condition. In the meantime, however, the active material may have been boiled out of the plates by overcharging and it it not until a failure of lights is reported after a slight, but unusual, battery discharge that it is discovered the battery capacity is gone, and the plates are but a few bare grids or sheets of lead completely riddled. As a matter of fact when you see plates with this strong brown color mentioned above, especially where the tops of the positive plates are brown, you can be reasonably sure that the battery is being overcharged. The tops of these plates when they are in good condition are grayish brown.

When an automatic device such as a stop charge relay which is supposed to look after the battery and prevent overcharging, is supplied on an equipment a man is inclined to set the battery charging rate as high as the capacity of the generator will permit and trust to the stop charge device for preventing battery overcharge.

This implicit confidence on the part of the axle light man has resulted in a great deal of trouble, for although the stop charge relay has been very carefully set when first installed, the variation in battery operating conditions as given above may be such as to either cause the cutout relay to operate too soon and never bring the battery up to full capacity or, especially in warm weather, the battery overcharging voltage may never reach the setting of the stop charge relay, and destructive overcharging of the battery may be experienced.

On the other hand, there is always a tendency toward blaming the new thing for any trouble which occurs and

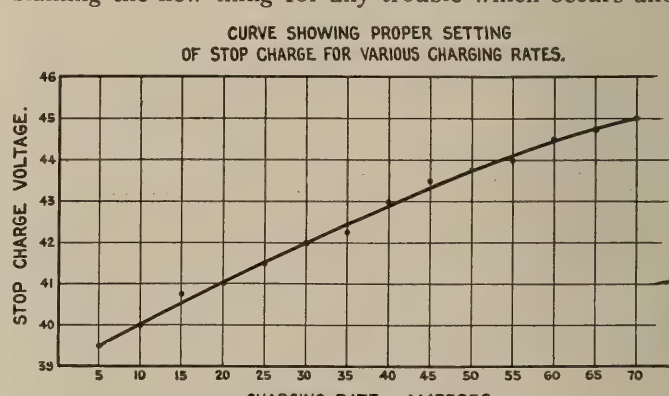

Fig. 17. Variation of Stop Charge Point with Charging Rate.

as the stop charge relay is one of the new things in operating axle equipments, it is usually considered to be the cause of all trouble and the result is that the repair men are inclined to fuss with it unnecessarily. To eliminate this difficulty, one company operating a great many axle equipments, sets all stop charge relays in the shops before going into service, and the setting of the relay is soldered

in place. To make it even more difficult to change, this company places the stop charge relay on the back of regulator panel so that the entire panel will have to be dismounted in order to alter the setting of the stop charge relay.

The stop charge relay should be set at a voltage of 2.45 for plante plates with normal charging current flowing. For rates other than normal charging current see curve Fig. 17. This is for a 32-volt system and voltage readings were taken at the board so that they include about 3 volts drop in the circuit. This will cause the relay to operate at a point shortly before the finish of charge is reached, but with a regular monthly overcharge, which may be obtained by cutting out the stop charge device for one trip, the battery should be kept in reasonably good condition. At least, it will be far better than the destructive overcharging at high temperatures which very often maintains in connection with stop charge relays.

Fig. 18. Pilot Cell Readings.

Fig. 19. Pilot Cell Readings.

The Ampere Hour Meter.

During the past five years there has been developed an ampere hour meter of the mercury type which is of robust construction so that it will stand up in the severe service of railway operation. These meters have been made in various types as follows:—

1. Single dial type with resetting mechanism so that pointer may be moved ahead 20% of the ampere hour discharge to make up for battery losses and the battery then placed on charge. The dial pointer will then gradually come back to zero as the charge proceeds and at the finish of charge will make a contact at the zero point, opening circuit breaker in the battery circuit.
2. Same as above with recording train to indicate total difference between charge and discharge.
3. Duplex recording trains, one to indicate total charge and the other total discharge.

Any of the above types may be very advantageously used in connection with lighting equipment. In fact, it is the firm conviction of the writer that an ampere hour meter should be used in connection with every storage battery in car lighting service. In straight storage service, especially where current for charging is pur-

chased, a saving in charging current may be effected which will pay for the cost of the meter in a few months. In headend and axle service, conditions of overcharging often maintain which might be detected and prevented if an ampere hour meter were installed in the battery circuit.

The duplex train integrating type is recommended for headend and axle equipments; the resetting dial circuit breaker type for straight storage.

A record showing the readings of both charge and discharge should be kept as this will serve as a very good indication as to the manner in which the storage battery is being cared for.

Pilot Cell Operation.

The gravity of the electrolyte is one of the best indications we have as to the condition of battery charge and offers an excellent means for the detection of the battery plate trobles. In a train lighting battery we have, however, from 16 to 54 cells each sealed up in its respective tank so that it becomes almost impossible to take gravity readings in every cell. If we pick out one particular cell, however, say the right hand front corner cell of the battery, the gravity of that cell may be taken as typical of all of the cells in series with it. A number of large roads take gravity readings of this pilot cell whenever a battery is received in the yard at either terminal. The accompanying curves, Figs. 18 and 19, of pilot cell and voltage readings shows how nicely this system works out.

This battery was placed in service January 1, and it will be noticed from the specific gravity curve that something was evidently wrong with the generating equipment as there was a steady decline in gravity up to January 10 when the equipment failed. This trouble was indicated on the 6th and 8th and might have been averted by a careful examination of the generating equipment, while the voltage readings for these days would have indicated the battery in fine condition. It should be noted that the gravity readings have all the fluctuations of the voltage curve and more, but these variations are much more exaggerated. Over the entire period from January 5th to April 15th the battery was operated either in an undercharged condition or some sulphation of the plates had occurred for the gravity of the acid was persistently low through this period. On May 15th, however, this was brought up to normal gravity and the sulphation or lack of charge restored. These pilot cell readings are of great assistance to any battery man, and a careful record should be kept of every battery operated.

BATTERY TROUBLES AND THEIR REMEDIES.

One of the most important things for the man in charge of storage batteries to learn is to recognize the first symptoms of trouble so that the battery may be given the proper attention immediately and the cause of that trouble removed. This will save much work and worry for yourself and a great deal of money in plate renewals for your company.

The diseases of storage batteries may be divided under the various heads.

1. Loss of capacity, shown by rapid falling off of voltage on discharge after the battery has been fully charged. This is due to:
   "A." Sulphated Plates.
   "B." Cells that have been badly overcharged many times, usually at high temperature.
2. Too rapid forming of positives causing them to grow excessively.
3. Hardening of negatives.
4. Buckling.
5. Reversal of cells.

1.-A. Sulphated Plates. This has been caused by one or more of the following things:

(a) Over discharge.
(b) Standing in discharged condition.
(c) Local short circuit or leakage due to grounds.
(d) Impurities in the cell.
(e) Low charging rate in plante type plates or the omission of the occasional overcharge.
(f) Electrolyte too strong.

This is indicated by the plates turning slightly grayish, or white in bad cases, or by the formation of grayish brown blotches on the plates. This may be due to the battery having been badly over discharged or having stood for some time in a partly discharged condition. It is usually possible to tell if either or both of these conditions have existed. Give the battery a few overcharges as given under "Treatment of Sulphated Plates."

Treatment of Sulphated plates.

Give the battery one or two overcharges at the normal rate until the plates gas freely—if this does not break up the sulphate on the plates or if it is a very bad case, it will pay to take the battery out of service and give it the alkali treatment as follows:

Remove the plates from the tanks and rinse in water, then place in new tanks and pour in a solution of pure caustic soda of a specific gravity of 1,200 formed by adding pure stick caustic soda to water. Connect the plates in the usual manner and charge at the normal rate. One charge in the soda will be sufficient to break up even the worst cases of sulphation.

If there is no good reason to believe that this explains the trouble, look further for local short circuits or grounds. (See grounds).

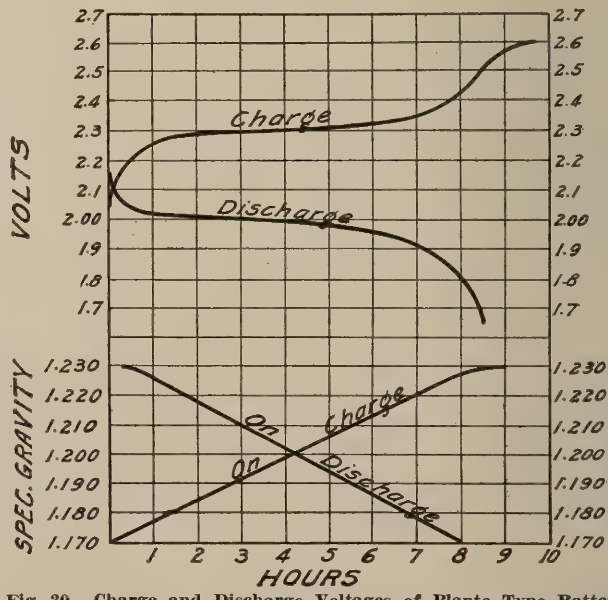

Fig. 20. Charge and Discharge Voltages of Plante Type Battery.

If it is due to a local short circuit of one cell you will find the voltage of that particular cell or cells lower than the other cells in the battery. Remove the cover from that one and examine it closely for a "tree" formation between the plates or see if the sediment in the bottom is not so deep as to touch the plates. Remove short circuit and clean all cells in the battery if necessary. (See cleaning). If the trouble is not found up to this point you can be reasonably sure that it is because the battery does not receive its occasional overcharge on the road.

1.—B. **Overcharging at High Temperatures.**

This will be indicated by a strong chocolate brown color in the positive plates and a dark slate color in the negatives. In normal operation the tops of the positive plates should be a trifle gray or muddy in color, but when excessive overcharging occurs, the tops will be dark brown. This is one of the best indications of overcharging and should be watched carefully.

It will also probably be noticed that the battery needs flushing, (filling with water) every week or 10 days. This also is a reasonably good indication of overcharging, although it may be due to warm weather.

To remedy the difficulty, either reduce the setting of the generator regulator if possible or reduce the setting of the stop charge relay. To do the latter, it will be necessary to charge the battery fully in the yard or ride the equipment on the road to see just how high the battery voltage does go on charge. Then set the stop charge relay slightly under that voltage.

In order to be sure that this is necessary however, a double dial ampere hour meter (see Ampere Hour Meters) should be placed in circuit and reading of charge and discharge noted for a few trips. There should be an excessive charge over discharge of at least 20% in ampere hours, and in addition to that a slight amount, say 10 ampere hours per day to make up for battery leakage losses, etc. Any greater overcharging than this, however, should be corrected for. On equipments that are badly overcharging it will be found that an overcharge of 500 or 600% is not uncommon.

2. **Too rapid forming of positives causing them to grow excessively.**

This is peculiar of the plante type plates and is caused by charging the battery too much. It may be caused by charging at too low a rate, although not excessively overcharging in ampere hours, but the battery is on charge too long a time. If there is too much overcharging, reduce the regulator setting as above; if overcharging is not excessive look after the setting of the regulator. If this does not provide normal battery current (see "Discharge") reaise it to normal. The ampere hour meter will be of service here.

If you find that the ampere hour readings do not indicate too strong an overcharge, have the electrolyte in the cells affected examined for impurities. There are certain corrosive impurities which if they get into a cell will cause the plates to "form" excessively. If the plates have grown too high it may be necessary to saw off the bottoms.

In plante plates new active material is formed from the reserved lead in the webbs and grids on every charge and discharge. This forming of active material may become excessive under the following conditions:

"A." Impurities in the acid which corrode the lead.
"B" Standing in a discharged condition.
"C" Short circuits.
"D" Charging at a low rate especially at high temperature.
"E" Unequal spacing of plates causing an unequal current flow over the surface of the plate.

3. **Hardening of Negatives.** This is very often found to be the cause of trouble in the negative plates and is detected as given under "Testing by means of Cadmium." It is difficult for the unexperienced battery man to detect this kind of trouble as it is necessary to watch the reading of cadmium voltage very carefully over the entire charge and discharge. The remedy is to give the plates a few strong charges and discharges at normal or twice normal rate as recommended by the battery manufacturer, or in severe cases it may be found easier to remove the negative plates from the cells and give them reversal treatment as given under, "Reversal of Negatives."

Reversal of Negatives.

Charge the battery fully and remove the negative plates, placing them in tanks filled with new electrolyte slightly above normal gravity, about 1.240. The plates should be connected into the charging circuit as positives instead of negatives with some dummy sheet lead plates for negatives. They are then placed in the charging circuit and normal or twice normal current, as recommended by the manufacturer, forced through the plates until they gas freely. The lead sponge of the negative plate should then be entirely converted first to lead sulphate as on normal discharge, and then to lead peroxide as usually occurs in the positive plate. Before you can be sure the reversal is complete, the charge should be stopped for a few minutes and if on closing the circuit again it does not immediately gas freely it is a sure indication that the reversal is not complete and charging should be continued further until plates gas immediately on closing the circuit.

When the plates are then completely converted into peroxide they should be set up again with new dummy plates and fresh acid, but this time be connected as negatives and the charging current forced through the combination. When the negatives are finally converted back into spongy lead and are again placed in the cells with their respective positive plates it will be found that the capacity of the battery has been very much increased. This treatment will remove any impurity such as copper from the negative plate. By using new dummy plates and fresh acid each time, these impurities will be entirely thrown off. If new dummy plates are not used on the last reversal of the negatives, the copper which was originally on the negative plates but on the first reversal was transferred to the dummy plates will be redeposited upon the negative plates.

4. **Buckling.** When plates discharge and sulphate is formed in the plates this sulphated active material takes up more room than the original active material in the positive or negative plates, so at every discharge there is a swelling up of the plates and on every charge a slight shrinkage. When the active material is confined so that it cannot expand this may cause strains to be set up inside of the plate which result in warping it out of shape and in some cases rupturing the plate.

These buckled plates may be straightened out by placing them in a press with spacing blocks between. The plates should be *fully charged* before removing from the cells, as the active material is then in a looser and more plastic state than when discharged.

5. **Reversal of Cells.** When one or more of the cells have become badly sulphated due to short circuits you may even find the voltage of that particular cell to be reversed in polarity. This individual cell or cells should be removed from the battery and given treatment recommended for sulphated plates above.

CLEANING.

A battery should be cleaned before the collection of sediment in the bottom of the jars becomes so deep as to touch the plates. This would cause a short circuit of the cell. Ordinarily with proper treatment a new battery will not require cleaning for about two years, and every 18 months thereafter. In cases where the service has been severe they may require cleaning in twelve months or possibly less.

A record should be kept in the general offices of all batteries in operation, and every month a list of batteries made that, judging from time they have been in ser-

vice, should require cleaning. The man on the job should keep careful watch over all batteries and not rely entirely upon the list furnished him from headquarters as batteries may often require cleaning long before he receives such notice and then again they may be in such good condition when notice is received that they will not require cleaning for several months. If a battery is found having deep sediment and requires cleaning it should be cleaned even though it is not shown on the list.

Method of Cleaning.

1. Be sure that the connectors are carefully wiped off so as to remove all copper sulphate formed by corrosion of the connector. If any of this falls into the cell it will seriously damage the plates.
2. Remove the connectors, sealing compound and the covers.
3. Connect the cells by means of temporary cell connectors. (Be sure and connect all cells in the right direction).
4. Fill the cell with distilled water so as to cover the plates by about ½".
5. Place the battery on charge at the normal rate, and continue until battery gases freely.
6. Look over each of the cells very carefully as the charge proceeds and take individual voltage readings of every cell as well as cadmium voltage readings as given under 'Cadmium Tests." If any cell is lower in voltage than the other cells in the battery or is later in gasing, examine it carefully for short circuit. This should be removed and charging continued until this cell gases.

If a cell is higher in voltage than the other cells of the battery or gases sooner than the others, it should be carefully inspected for being in a sulphated condition, and if badly sulphated should be removed from the battery and given special treatement. (See "Treatment of Sulphated Plates.")

7. The elements should then be removed from the tanks and carefully inspected. They should not, however, be left standing in the air very long or the negatives will heat. This is caused by sulphation of the lead sponge and should be carefully avoided.
8. If any of the plates are found to be badly buckled they should be separated and straightened out under a press with suitable spacing blocks between the plates. The elements are then immediately placed in a new set of tanks, connected up again with temporary wire connectors and charged again as above until every cell gases freely.
9. Specific gravity of electrolyte in the new tanks should then be adjusted to normal value of 1.220.
10. After discharge capacity test has been made satisfactorily (see "Discharge Capacity Test," below) the covers should be replaced, the tank sealed with filling compound and the connectors replaced.
11. Connectors should be very carefully soldered, for if this is not carefully done connectors will break loose when placed in service and cause a failure of the equipment.

Discharge Capacity Test.

It is very important to know whether or not the battery is up to normal capacity, so after it has been fully charged in the new tanks and the electrolyte adjusted to normal gravity of 1.220, the battery should be discharged at the normal 8 hour rate (the rated ampere hour capacity divided by 8). Voltage readings of each individual cell should be taken every hour until one or more of the cells have dropped to 1.8 volts and then the reading should be taken at 15 minute intervals until the voltage of the battery as a whole has dropped to an average of 1.8 volt per cell. Cadmium readings as given under "Cadmium Test" should be taken for each individual cell as these readings will indicate whether the trouble in any cell of low capacity is due to positive or negative plates. Any cells showing less capacity than the others should be given immediate attention. A report giving each of the above values for every cell in the battery should be made out.

(To be continued.)

Practical Stunts

I had a little experience some time ago in the reduction of voltage of a generator from 110 to 55 volts which may be of interest although it was not in connection with a car lighting equipment. The generator which was gas engine driven had been designed for 110 volt operation but was operated at 55 volts in connection with an electro plating plant.

The commutator sparked very badly, in fact, destructively, so I suggested that they reduce the generator speed somewhat so that the generator field magnetism might be increased. The engine speed was reduced from 250 to 200 r. p. m. and the field current increased to bring the voltage up to 55 volts. This resulted in almost perfect commutation and little trouble was experienced after that.—F. R. F.

(Editors Note) This is a fine illustration of one of the points we discussed in our March lesson. That is, the relation of magnetic field caused by the field windings, to the cross magnetism due to the current flowing through the armature windings.

In this case mentioned the generator field magnetism had been reduced to one-half its original value, while the armature current magnetism at full load remained as strong as at 110 volt operation. The effect of this was that the armature magnetism was strong enough to greatly distort the magnetic field of the generator as shown in Fig. 13, Page 247 March issue. This caused the brushes to commutate armature coils, while they were still generating a slight voltage, which resulted in short circuiting the coils under the brushes, arcing the commutator badly and at the same time overheating the armature coils on account of the heavy short circuiting current flowing through them.

FOR US ALL

The joy of a job that bites and tries to throw you is that it makes a man of you; and if you get away with it, you become a valuable man to your employer. * * *. There is a great element of danger in an easy job.—W. M. W.

SOME NEW PULLMAN EQUIPMENT.

An order was recently placed by the Pullman Company for equipping 50 of their new cars with Gould type G., 2-kw., 30-volt "Symplex" car lighting systems, using type D. S. 80-15 350 ampere hour Gould storage batteries.

In addition to the above, 14 of the old type K. equipments are to be replaced by the new type G. "Symplex" system. This change was made for purposes of standardization.

NEW PENNSYLVANIA EQUIPMENT.

The Pennsylvania Company has just placed an order for 100 sets of Edison Storage Batteries of 25 cells each of type A. 8 H. car lighting cells which are to be installed on some of the new cars ordered by that company. These cells are to be of the new car lighting type, having extra high cans to provide for 3 inches of electrolyte above the tops of the plates. This permits of the batteries going for considerable time without flushing.

A complete list of the cars and equipments in this order are not at the present time available, but these will be published in our next issue.

CRAVENS ELECTRIC COMPANY.

It is with especial pleasure that we announce the formation of the Cravens Electric Co. and its entrance into the railway field. They will do a general engineering, manufacturing and selling business in electrical apparatus, making a specialty of developing new devices to meet specific requirements for their customers in addition to their complete general line.

The company was formed by Mr. Geo. W. Cravens, well known to our readers as the editor of our Shop Section and as an associate member of the Association of Railway Electrical Engineer, American Institute of Electrical Engineers and numerous other technical societies, and as a frequent contributor to the technical and industrial press on the many problems incident to the design and production of all kinds of electrical equipment.

Associated with Mr. Cravens in the new enterprise are a number of experienced men in this field, the best

GEO. W. CRAVENS.

known of whom to our readers is Mr. Ralph Birchard, also a former Associate Editor of this paper. Mr. Birchard will be the Treasurer of the company, in addition to his present duties as a Chicago representative of the General Motors Co.

Mr. Cravens seems eminently fitted to act as the executive of an enterprise of this sort as he has been in the electrical business for over nineteen years. He went with the General Electric Co., at Lynn, Mass., in February, 1893, moving to Schenectady, N. Y., in 1894, and remaining there until 1907. While with the G. E. Co. he worked on every type of apparatus built by the company excepting steam turbines, acting as Chief Draftsman for six departments and as Assistant Engineer in three departments, at different times.

In 1907 Mr. Cravens came to Chicago as an engineer for the Goodman Mfg. Co., makers of electrical coal mining machinery, having charge of their detail designing and drafting. At the end of ten months he was put in charge of all of their designing and held this position until he resigned to go into business for himself as a Consulting Engineer. Fifteen months later, upon the reorganization of the Delta-Star Electric Co. on their present basis, Mr. Cravens went with them as Engineer and has acted in this capacity during the past two years.

MOTOR DRIVEN MILLING MACHINE.

An interesting example of a direct application of electric motor to a milling machine, which exemplifies the present tendency in motor-driven machine design, is shown in the accompanying illustration. Economy in space and efficiency in operation are the two most important conditions attained by such application.

It will be noted that the motor is bolted against the column of the machine and that it is provided with a long pinion. This pinion drives a large raw-hide gear mounted on a sleeve, on which is also mounted a smaller raw-hide gear. These two gear wheels on the sleeve are movable on a fixed stud, thus allowing the large raw-hide gear wheel to mesh into the smaller of the two steel gear wheels on the milling machine spindle; or by shifting the two raw-hide gear wheels on the smaller one of these will engage with the large steel gear wheel on the spindle.

When the motor drives directly through the large raw-

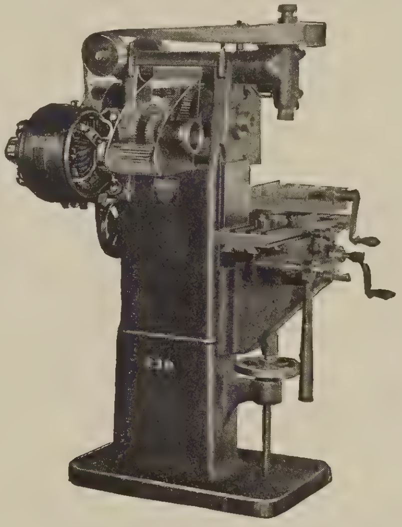

Fig. 1. Chicago Milling Machine. Roth-Motor Driven.

hide gear onto the small steel gear on the spindle, the large raw-hide wheel acts as an idler only, but when the drive is through the large raw-hide gear and then through the small to the large steel wheel on the spindle, the gearing acts to reduce the speed of the spindle.

The motor is a one H.P., 1200 R.P.M. machine, wound for 230 volt circuit. It is provided with a double-throw service so that the motor in operation also runs on 115 volts. Thus, in starting on 115 volts and with the reducing gear in operation the slowest speed of the spindle will be 16 R.P.M., which can be increased by field weakening up to 232 R.P.M., at which point the 230-volt circuit would be used with full field at 232 R.P.M. and 464 R.P.M. with weak field. With the motor geared direct, the speed with 115 volts full field is 340 R.P.M., which can be increased to 680 R.P.M. with weak field, at which point the 230 volts would be used, giving again 680 R.P.M. with full field and 1000 R.P.M. with weak field.

The milling machine is a type known as the "Chicago," manufactured by the Chicago Tool Company. The motor is manufactured by Roth Brothers & Company, Adams and Loomis Streets, Chicago, Illinois.

Mr. C. W. Scott who has for the past four or five years handled the switchboard appliance department at

the general offices of the Westinghouse Electric & Manufacturing Co. at East Pittsburgh, Pa., has accepted a position as District Sales Manager of the Economy Fuse & Manufacturing Co., having charge of the sales in the New York territory of this company, with offices at 106 Fulton St., New York.

Mr. Scott's extensive experience in the appliance field will prove of great value to the company in his present position.

ELECTRICAL LIGHTING ON INDIAN ROYAL TRAIN.

During a recent visit of King George V. to India, the Royal party had occasion to make a rather extended tour over the East Indian Railway.

The Royal train was equipped throughout with electric lighting of the Stone system. One of the Stone Companies electricians, loaned to the East Indian Railway during the Royal Tour, was presented with a gold tie pin by the King personally.

The Foreman in charge reported that during the entire trip the electric lighting service was perfect.

STORAGE BATTERY CARS.

Bulletin No. 13, just issued by the Gould Storage Battery Company, deals with the economics and construction of the storage battery car. It describes the standard type of car made by the Gould Company, and shows the condition under which storage battery cars can be used most profitably.

G. E. TRAIN LIGHTING LAMPS.

The G. E. Lamp Company has just issued a new bulletin on standard train lighting lamps which should be in the hands of all car lighting men. The bulletin shows all the various standard types of lamps in actual size and gives all necessary data pertaining to each.

OZONE AND VENTILATION.

This is the title of a new bulletin by the General Electric Company which covers this subject in a very complete manner. The bulletin is much more than the usual trade bulletin, as it goes into subject of ventilation and removing impurities in the air in a scholarly manner. It is a 16 page booklet and well illustrated with cuts showing the application of Ozonators.

NEW DELTA-STAR CATALOG.

"The Delta-Star Electric Company, of Chicago, are distributing their new catalog and price list of enclosed fuses, particular attention being called to the fact that the method of indication is absolutely guaranteed. The numerous illustrations show details in construction which should be of interest to users of enclosed fuses."

Patents

1,020,975. Selective Signaling System. E. R. Gill, assignor to H. E. Merrell, New York, N. Y., and O. J. Hamlin, Smethport, Pa. A selector for a composite telegraph and telephone system.

1,021,054. Expulsion-Fuse Circuit-Breaker. W. J. Lietzenmayer, assignor to Allis-Chalmers Co., and Bullock Electric Manufacturing Co. The fuse is mounted in a switch arm so that on blowing it releases the latch and forces the arm to open position.

1,021,195. Socket for Electric Lamps. C. Knauff, Chicago, Ill. A long cylindrical casing containing compressible contact plungers has a lamp socket at one end and a plug rotatable so as to contact with the plungers at the other end.

1,021,266. Turbo-Generator. R. H. Rice, assignor to General Electric Co. A horizontal unit with an integral casing divided into three tranverse annular heads, a generator-ventilating fan being in the middle one.

1,021,774. Regulation of Electric Circuits. M. Guett, assignor to Hart & Hegeman Manufacturing Co., Hartford, Conn. A double-pole rotary snap switch with a third auxiliary bridging member.

1,021,900. Storage Battery. J. L. Smith, Detroit, Mich. Includes end and intermediate spacing frames and support sheets interlocked to form a liquid holder with several cell compartments.

1,021,989. Storage-Battery Electrode and Process of Making It. W. Morrison, Des Moines, Ia. Comprises a tube of active material, a porous envelope inclosing the same, and a strip of wire gauze helically wound on the envelope.

1,021,990, 1,021,991 and 1,021,992. Binder for Peroxide Active Material and Process of Making It. W. Morrison, Des Moines, Ia. In the first of these patents tungsten is included in the binder compound; in the second tantalum, and in the third niobium.

1,021,993 to 1,021,996, inclusive. Process of Binding the Active Material of Positive-Pole Lead Electrodes. W. Morrison, Des Moines, Ia. The first two of these patents describe two methods of impregnating peroxide of lead with a tungsten compound. The third patent relates to the impregnation with a tantalum compound, and the fourth to a similar process with a niobium compound.

1,021,997. Storage-Battery Conductor or Support. W. Morrison, Des Moines, Ia. Consists of lead, a member of the periodic sulphur group having an atomic weight higher than that of sulphur, and antimony.

1,022,000. Electropneumatic Tool. A. Palmros, assignor to Pneumelectric Machine Co., Syracuse, N. Y. A reciprocating tool operated by a compact motor-driven air-compressing mechanism.

1,022,182. Method of Wire-Drawing. J. T. H. Dempster, assignor to General Electric Co. A method of drawing tungsten wire consists in applying to the wire an adherent graphite coating by highly heating graphite while in contact with the wire and then passing the wire through the die.

1,022,234. Shade-Holder. G. W. Goodridge, assignor to Bryant Electric Co. Has lower and upper abutment rings that are screwed together to engage the supporting bead on the socket.

1,022,514. Arc-Lamp Hanger. G. E. Stevens, assignor to General Electric Co. A locking device adapted to engage and disengage a plug.

1,022,541. Arc Lamp. R. Fleming and E. J. Guay, assignors to General Electric Co. A magnetite arc is started by bringing the electrodes together longtitudinally and laterally.

1,022,543. Holder for Lamp Filaments. L. Glaser, assignor to General Electric Co. Consists of a mixture of refractory oxides with a pure thoriumoxide surface.

1,022,707. Solenoid Controller. F. W. Smith, assignor to Sundh Electric Co., New York, N. Y. A solenoid automatically controls the motor circuit and its resistance.

1,022,797. Shock-Absorbing Rosette. S. B. Paine, assignor to General Electric Co. Comprises a flanged tubular plug having a countersink in its upper end, and a vibration-absorbing cushion of felt between the plug and the body of the rosette.

1,022,815. Separable Attachment Plug. R. B. Benjamin, assignor to Benjamin Electric Manufacturing Co., Chicago, Ill. The cap can be inserted into the plug by a straight push.

1,022,834. Electrical Fuse. Samuel F. Estell, Florence, Cal. A rechargeable cartridge fuse.

1,022,895. Shade-Holder.. W. S. Stapley, assignor to Bridgeport Brass Co., Bridgeport, Conn. The locking clamp is made of wire.

1,022,948. Conduit. A. P. Hinsky, assignor to Eastern Flexible Conduit Co., Brooklyn, N. Y. Consists of an inner helically wound tube, an intermediate slotted fiber tube, wound in the opposite direction and an outer woven texile covering.

1,023,102. Circuit-Breaker. C. C. Badeau, assignor to Sears B. Condit, Jr., Boston, Mass. The tripping coil has a U-shaped armature.

1,023,121. Electric Lighting System. C. E. Bonine, Philadelphia, Pa. A compound generator on an automobile has an automatic regulator governing its connection to a storage battery for charging.

1,023,122. Electric Lighting and Engine-Starting System. C. E. Bonine, Philadelphia, Pa. Includes a generator, battery and lighting set as above, but a throw-over switch is arranged to change the generator to a motor for starting the engine.

1,023,134. Alternating-Current Motor-Controlling Apparatus. J. Dillon, assignor to Otis Elevator Co., Jersey City, N. J. Includes a set of relays for controlling the starting resistances.

RAILWAY ELECTRICAL ENGINEER

The Official Journal of the Assciation of Railway Electrical Engineers

Vol. 3 CHICAGO 106 N. La Salle Street APRIL, 1912 $1.00 per year U. S., Canada and Mexico $1.50 per year Foreign No. 11

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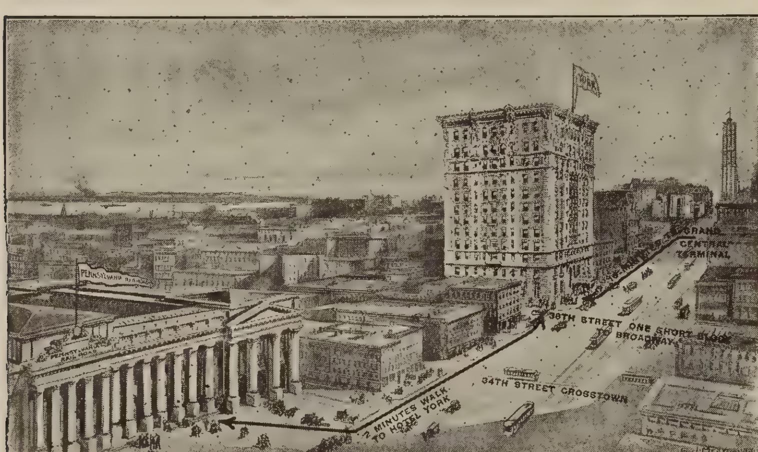

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DICKINSON MANUFACTURING COMPANY, Springfield, Mass.
KURT R. STERNBERG, Treas. and Genl. Manager.

Battery Talk No. 4

Why The Salom Battery Gives A Higher Voltage

Anyone connected in any manner with the electrical profession appreciates the value of good contact in all electrical connections. For instance, take a joint in a given size of wire which is to be used as an electrical conductor; if the joint is only wrapped it will give a high resistance and consequent loss of voltage, but if the joint is metallically welded or soldered this is not the case. This is due to the resistance between the two conductors because of the imperfect contact which becomes aggravated as time goes on. The same is true in a storage battery plate where poor contact exists between the grid and active material, only in this case the trouble is much more serious, as in addition to bad contact and high resistance, there is a local electrolytic action set up at this point between the grid and active material in the presence of sulphuric acid.

Salom storage batteries have the active material placed in the conducting or supporting grid under thousands of pounds pressure to the square inch, WHICH COLD WELDS THE ACTIVE MATERIAL TO THE SUPPORTING GRID, MAKING THE MOST PERFECT CONTACT POSSIBLE, which reduces the resistance of the plate, and therefore the internal resistance of the Salom storage battery is lower than any other lead battery manufactured.

The pasted plate having its material put into the supporting grid by hand corresponds exactly with a joint made between two pieces of wire that are not soldered or welded. The Salom plate represents the soldered or perfect contact, because the active material has been cold welded to the supporting grid. Furthermore, in the Salom negative plate there cannot be any shrinkage of the active material, such as occurs in pasted plates, because of the exceedingly high pressure under which the spongy lead is applied; IN FACT, THERE IS A VERY SLIGHT EXPANSION. SHRINKAGE CAUSES BAD CONTACT BETWEEN THE GRID AND ACTIVE MATERIAL WITH A CONSEQUENT LOSS OF CAPACITY AND EFFICIENCY.

The higher the internal resistance (due to the above causes) of a storage battery, the shorter the life of the plates composing it, due to the action that takes place between the active material and the supporting grid.

A properly soldered joint between two electrical wires will make a permanent joint, maintaining the same efficiency through its entire life; whereas, an unsoldered joint deteriorates from the day it is made due to the action caused in the joint by the high resistance.

In a storage battery the results of poor contact are similar to the results in an unsoldered joint. Therefore, when we cold weld the active material to the grid by the Salom process, we produce a plate of the lowest possible internal resistance, which remains constant throughout the life of the plate and maintains a contact between the active material and the conducting or supporting grid which produces a higher voltage by 5% than has ever before been obtained in a lead storage battery.

Niagara Lead & Battery Company

Niagara, Falls, N. Y.

Effect of Storage Battery Gases on Health and on Instruments

Letter No. 2

Several years ago, an ex-Naval Officer, who received a sword from Congress for conspicuous bravery in one of the engagements of our war with Spain, was asked if he would volunteer his services in the event of hostilities.

"That would depend entirely on the nature of the duty," he replied. "If I could be reasonably sure, either of complete annihilation, or absolute safety, I would go. The probability of 'passing out' does not worry me, but I DO draw the line on becoming an invalid or cripple—a burden to myself and family for the remainder of my days."

A man who, in the excitement of combat, with its attendant forgetfulness of personal safety, gives up his life in the performance of duty, is pronounced a hero, and has statues erected to his memory. But the one who sacrifices his HEALTH on the altar of duty is SHELVED, and becomes a NONENTITY.

Nature has provided us with a very sensitive detector of unwholesome odors. Everyone prefers to breathe pure air rather than sewer gas. While all odors that are unpleasant are not necessarily harmful, the majority are. When irritation of the mucous membrane, indicated by violent coughing and sore throat, is produced by inhaling a gas, the ultimate deleterious effect on the lungs, and resultant ill health, are too apparent to need comment.

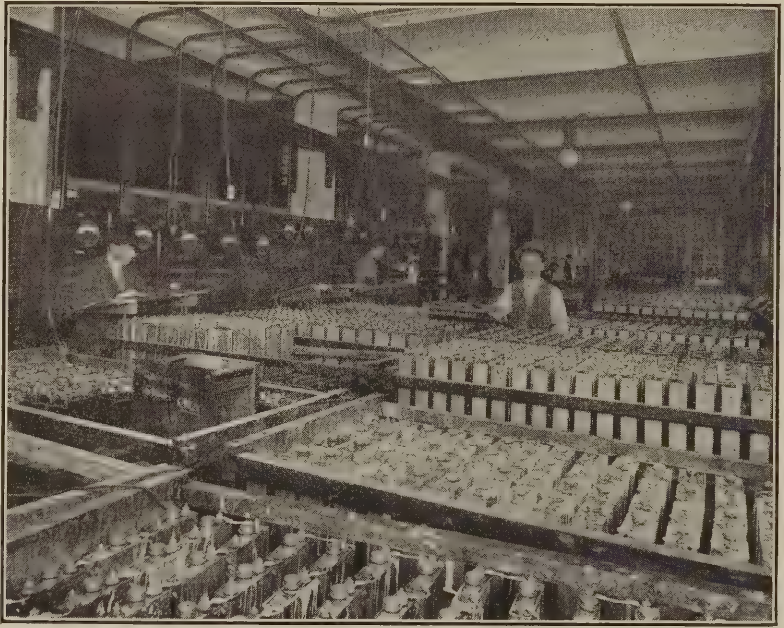


Fig. 16. Forming Room, Edison Storage Battery Co., Orange, N. J.

In the manufacture of lead-sulphuric acid types of storage batteries, the Forming Room is located as far away from the remainder of the Plant as it is possible to place it. Powerful exhaust fans are employed to remove the fumes. A superintendent who would locate this Forming Room within twenty feet of a Punch Press Department, or a Stock Room, and enclose it by WIRE NETTING, would get no further than the preliminary sketch of the plans. He would be looking for another position.

Since the erection of the Factory of the EDISON STORAGE BATTERY four years ago, the Forming Room, wherein several thousand cells are being charged and discharged all the time, has been separated from the Punch Press Room, Stock Room, Assembly Department, and Shipment Department, BY WIRE PARTITIONS ONLY. The electrical instruments and other devices on the switchboards in this room are untarnished. A large assortment of brass, steel, and other metal in the Stock Room show no corrosion. There is not a ventilating fan on the floor. Between 200 and 300 men are at work there. Not one of them has noticed the slightest odor.

The explanation is exceedingly simple.

When a storage battery is charged, hydrogen gas forms on the negative plates, and oxygen gas on the positives. These gases, in the form of minute bubbles, rise to the surface of the solution and, being lighter than air, float away. Being formed in and subsequently passing through the solution, these minute bubbles each convey a small particle of whatever chemical the solution is composed of; if they are formed in a lead-sulphuric acid battery, sulphuric acid is the cargo; if in an Edison Type Battery, potash.

When these bubbles rise from the surface of the electrolyte and come in contact with an object, they either remain until evaporation disintegrates them and deposit their cargo of acid or alkali, or they burst and accomplish the same result.

The gas vent of a lead type cell is open and the bubbles may therefore pass through freely and away.

The vent of the Edison Cell is a check valve. To get out, the gases must LIFT this valve by pressure formed within the otherwise hermetically sealed steel containing can. In doing so, a great majority of the little bubbles are burst, and the potash drains back into the cell. A few of them get by this check valve when it lifts, and float away.

Sulphuric acid attacks steel. Potash preserves it. Anyone at all familiar with machine shop practice knows that a saturated solution of soda or potash is flowed over the tool and stock in a lathe. No one would think of using a sulphuric acid solution for this work.

When installed in signal towers, such cells are usually placed in a room separate and apart from all instruments and other apparatus. The installation expense is quite a factor. In specifications covering the installation of Edison Storage Battery no mention need be made of separate rooms. An open door is the only ventilation required. No more attention need be paid Edison Cells than if they were cans of lubricating oil—the contents of both of which preserve steel.

Another factor enters into the consideration of these distinct types. The lead type storage battery is encased in a hard rubber jar. The Edison Battery is encased in a steel jar. It does not take a Sherlock Holmes to figure out which of the two containers is the more serviceable and the less apt to rupture and empty the contents on the floor.

We ask that in operating Edison Storage Battery the exterior of the cells be kept clean and that they be replenished with distilled water when necessary. The other minor directions, very few in number, are secondary in consideration.

The African Versus the Eskimo from the General Utility Standpoint

I once knew a charming young lady whose aged spinster aunts objected to her fiance, because he was irregular in attending prayer meetings. Had she been guided by their advice, she would have lost a perfectly good husband.

Considerable agitation has been raised by certain battery manufacturers of late, because of the TEMPORARY effect of LOW TEMPERATURES on the capacity of the EDISON STORAGE BATTERY.

For reasons best understood by those who have grasped at this straw as it floats by, no verbal emphasis has been given to the LASTING, DESTRUCTIVE EFFECT OF HIGH TEMPERATURES ON OTHER STORAGE BATTERIES.

As the weather has gotten into the habit of giving us a variety, and as sauce prepared for goose is of equal gastronomic value when partaken of with gander, a short dissertation on this temperature subject may prove of interest.

In "Standard Handbook for Electrical Engineers," published by the McGraw-Hill Book Publishing Company, we find, under Section 9, an excellent treatise on storage batteries.

In Paragraph 46 thereof, we read, in black faced type:

"Cells, however, deteriorate rapidly if worked at temperatures above 100 degrees Fahrenheit, and this, therefore, should be the maximum temperature where possible that they are subjected to."

In paragraph 85, "Rules for Operation:"

Rule 15. "Never let the battery temperature rise above 110 degrees Fahrenheit and, if possible, keep below 100 degrees Fahrenheit."

It would be interesting to know how the operator is going to follow directions, when the thermometer is 90 degrees to 110 degrees, as it was during several months last summer, and as it is practically all the time in the Tropics. When a battery is charging or discharging, heat is generated within.

From nickel hydrate and iron oxide received from the Edison Chemical Works in Silver Lake, N. J., samples of the hydrate are made up into positive plates, and samples of the oxide into negatives.

The positives are assembled into test cells with previously tested iron oxide negatives. Similarly, the iron oxide negatives are assembled with known value positives.

These test cells are put into a steam jacketed box and KEPT AT A TEMPERATURE OF 132 DEGREES FAHRENHEIT FOR 450 CHARGES AND DISCHARGES. They are then run through four cycles of charge and discharge at normal temperature. IF THEY DO NOT SHOW RATED CAPACITY AFTER THIS TREATMENT, THE NICKEL HYDRATE OR IRON OXIDE, OR BOTH, AS THE TEST MAY INDICATE, ARE REJECTED.

If capacity IS shown, the hydrate or oxide is deemed good enough for EDISON BATTERY manufacture.

Wishing to see how far this could be carried, Mr. Edison has put several cells through a DRASTIC TEST OF 1,450 CYCLES of charge and discharge AT 132 DEGREES FAHRENHEIT, AND THEY STILL SHOW EIGHTY PER CENT OF THEIR RATED CAPACITY AT NORMAL TEMPERATURE.

The capacity of an EDISON CELL, charged at 132 degrees Fahrenheit, is about one-third its normal capacity. But if charged at temperatures between 32 degrees and 110 degrees Fahrenheit, it may be discharged at temperatures to and including 132 degress Fahrenheit, and show rated capacity, and usually above. The higher the temperature on discharge up to about 132 degrees Fahrenheit, the greater the capacity.

Actual tests have shown that an EDISON CELL may be placed in boiling water, and put through several cycles of charge and discharge, without injury; it may be subjected to a temperature of 47 degrees below zero Fahrenheit for a day, in either a charged or discharged condition and, when thawed out, will show, on charge and discharge at normal temperatures, normal rating.

Some months ago we sent a battery of EDISON CELLS to the New York Testing Laboratories for an impartial, authentic test as to the effect of low temperature. We had experienced no serious difficulty with the several thousand automobiles, trucks, delivery wagons, etc., operated here, in Canada and other parts of the country not blessed with California climate, but wished to know what a theoretical test would show. When these tests were obtainable, we published them in bulletin form, and distributed them freely.

Summarized briefly, the results are of interest to the ice man only. If he wishes to operate his delivery wagon by EDISON CELLS, he must place them in a reasonably tight box, underneath his wagon, and not pack them in with the ice.

When a tank of water is warmed, as a cell is when charging, and placed out of doors when the air temperature is low, it takes a long time for it to freeze solid, or even to reach 40 degrees Fahrenheit. It takes a great deal longer to freeze a cake of ice than it does to boil an equivalent volume of water.

Africa is hot. No one denies this fact.

Greenland is cold, and the North Polar Region is colder.

When Rear Admiral Peary reached the Pole HE WAS ACCOMPANIED BY AN AFRICAN.

Therefore, it is apparent that if an African goes to the Arctic and wraps up, as does the Eskimo, he can get along about as well—in fact, better than those Eskimo who fell by the wayside in that last historic dash.

Eskimo who have come to the States have not thrived. The heat prostrates them. It is reasonable to suppose they would not last long in Africa.

IT IS APPARENT THAT AN AFRICAN CAN LIVE AND THRIVE IN THE TROPICS AND ARCTIC EQUALLY WELL, AND AS AN ESKIMO CANNOT LIVE IN THE TROPICS, THE AFRICAN IS THE MORE PERFECT HUMAN MECHANISM OF THE TWO.

General Utility Formula:

Edison Battery--African.

Other Batteries--Eskimo.

ANSWER: EDISON BATTERY.

Q. E. D.

People go to a great deal of expense and trouble to provide themselves with fur and other warmth retaining garments in Winter. In addition, a little invigorating fuel is sometimes indulged in. Yet some people object to placing their batteries in wind-proof compartments, and to giving them a drink of PURE WATER from time to time. Fortunately, common sense is the prevailing attribute of the great majority of the Public and the minority, therefore, do not worry us.

ELECTRIC VEHICLES UNAFFECTED BY BLIZZARD.

Through Chicago's blizzard of February 21st, and in the teeth of a snow-filled gale, blowing fifty miles an hour, the four Electric Omnibuses operating between the railroad stations and the store of Carson, Pirie, Scott & Company made their regular schedule, unaffected, while hundreds of gasoline automobiles and trucks were overwhelmed by the high wind and deep snow drifts, and left abandoned. The storage-battery trucks made fifty round trips on that day, carrying eight hundred people, the largest number for any day during the four weeks they have been in service. An account of these Field Omnibuses using Edison Batteries was given on page 210 of our issue for January 27th, 1912.—From Electrical World, issue of March 2, 1912.

Efficiency

The term EFFICIENCY is as indefinite in real meaning when applied to storage batteries, as is "PREDESTINATION" in matters religious.

Ordinarily, PRACTICAL EFFICIENCY means ability to CONTINUE useful work over a protracted period, with minimum deterioration and expense. Inasmuch as a person's time is worth money, the more time one has to spend taking care of a piece of apparatus, the more it is costing, in addition to the depreciation, and the less the PRACTICAL efficiency of the device to him.

We are told in one breath that lead batteries have 75 per cent efficiency, and in the next, "Give the battery a prolonged overcharge every two weeks. This overcharge should continue at about 60 per cent of the eight-hour rate until free gasing of the negative plates has continued for an hour." Again, "Cells which stand a considerable time unused—say as long as 45 days—should be overcharged as directed. It is best to give them a slight charge and discharge about once a week if practicable."

EDISON BATTERY instructions suggest that they be overcharged at the end of thirty days and sixty days of use and therafter every two months. Overcharging in this case means prolonging the charge for several hours more than the normal charging time, a few times a year. This amounts to very little as compared to overcharging every two or three weeks.

The lead battery claims 75 per cent watt hour efficiency. It would be interesting to know to what account the current wasted on these overcharges, which performs no useful work other than acting as a "tonic," is charged up to.

Puts one in mind of a stereotyped regular contract, PLUS EXTRAS.

Practical folk will agree that EFFICIENCY means the greatest amount of work done in a year or in five years, with a minimum of expense. EVERYTHING must be counted.

This subject is one that can be best expressed in parables:

A windmill salesman comes along and sells to an unsuspecting farmer a perfectly good windmill, and a new kind of TANK. The farmer has learned to look upon TANKS as containers of water, or whatever is pumped into them, for its storage until used, when and how he desires.

The outfit arrives and is installed by the windmill men. The farmer pays his money and sits down to peruse the forty-page book of "Directions and Rules for Operation" he was handed when the transaction was closed. He reads:

1. Don't drain ALL the water from the tank at ANY time except as below specified.

2. Never allow water to be pumped into the tank until it is at least two-thirds empty.

3. Then start windmill RIGHT AWAY and don't let it stop pumping until the tank is full.

4. Never let tank temperature rise above normal.

5. Go over all the rivets of the tank once a week, using a CADMIUM hammer, to determine their condition.

6. Buy a water meter, connect it to the tank once a week, and see if the water is flowing properly; if not, pump water in, allowing it to overflow until it does run out properly.

7. If you are called away for over forty-five days, and don't use the tank, pay someone to come around every two weeks, start the windmill, and pump water into it. It is better to let some of the water run out before you do so.

8. If tank is to remain unused two months or longer, send for a boiler maker and his BLOW TORCH, drain the tank, remove all the rivets, take all the plates of the tank apart, wash them thoroughly, and store them away.

9. If the plates have swelled, hire a road roller or a cotton press to squeeze them back to thickness.

10. When you come back and want water, send for your boiler maker and his blow torch, reassemble tank, using new rivets, allow tank to overflow for some time before using the water.

11. Be sure your main pipes from tank do not burst at any time, because if you remove the water from the tank too quickly, it will buckle the plates and ruin it.

12. Be sure the windmill never pumps water into the tank too fast, as this will injure the tank.

13. Every twelve or eighteen months remove all sediment, send for your boiler maker and his torch, remove all rivets, take the tank apart, clean all the parts, reassemble, using new rivets.

14. Never allow the tank to be filled when the temperature of the same is above normal.

15. Similarly, never use water from the tank when the temperature of tank is above normal. Your convenience and necessity is of secondary consideration.

16. If you do not have use for all the water your mill pumps, better let two-thirds run out about once every month and refill the tank.

17. Filling and using tank causes the water to change its density, so that you must buy a HYDROMETER and test said water once a week. If reading of the hydrometer is .05 from standard density, add chemicals or pure water to bring it right.

The farmer's crops suffer, but he sticks manfully to his task. Finally, after about the 300th time water has been pumped into the tank, he happens to glance skyward and notices a flock of large black birds soaring overhead. He has performed an autopsy!

He tears out the tank, uncouples the windmill and goes back to the well bucket.

About this time, a drummer comes along from another windmill and tank manufacturing concern. The dogs are unleashed! But he waves a Guarantee flag of truce, and THIS time the farmer asks first for "Directions and Rules for Operation" of his particular kind of tank.

He finds:

1. Let tank run over a little while when you have used it for thirty days and sixty days; thereafter about once every two months.

2. Put some water into the little receptacle we furnish, and every now and then turn the faucet of this little device until the bell rings.

3. Keep the exterior of your tank clean.

4. Forget the tank the rest of the time.

5. If, at the end of four years' use, the tank is incapable of showing its original rated capacity, we will repair or replace it free of charge.

THE FARMER GRADUATES FROM THE WELL BUCKET FOR GOOD.

Do you think that the first salesman could have gotten within a mile of that farmer if the second had arrived first with his "Directions for Operation" referred to in his catalogue?

Before purchasing ANY piece of apparatus, it is a wise plan to ask the Manufacturers for a copy of the Instructions on which the Guarantee is based.

It is then a good plan to pay a lawyer a few dollars to tell you whether or not the guarantee MEANS anything.

Then, with a full realization of the duties you must perform, it is up to you to figure whether it will pay you to spend MORE money for a device that will LAST, stand considerable neglect, and GIVE YOU GREAT PEACE OF MIND, or whether you wish to pay less money originally, face a large deterioration charge, figuring your own time at its value.

I wish to especially call your attention to the fact that the EDISON STORAGE BATTERY can be recharged at ANY TIME WITHOUT DETRIMENT, irrespective of the energy which has been taken from it.

It can also be taken from charge and put on discharge, regardless of whether it has been fully charged or not.

The EDISON STORAGE BATTERY may be charged at four times its normal rate for fifteen minutes, or three times its normal rate for thirty minutes, or twice its normal rate for one hour.

"In Time of Peace Prepare for More Peace"

There is something indescribably fascinating to a man, with red blood in his veins, in witnessing a good scrap between evenly matched men.

A valuable lesson is learned.

The successful pugilist is not the man who punches a bag in his training quarters all day. Such parlor tactics might make the brain very expert in DIRECTING blows to land on microscopic spots on the punching bag; but when the man pits himself against his antagonist in the ring, his body must be able to *take* punishment, while his brain is directing his fists in *giving* it; hence, the necessary sparring partner.

We spend millions annually in constructing large battleships. We send them out to "punch the bag." So expert have our ships become that the target is riddled forthwith. The "brain" and "fists" work well together, and the "body" *backs up* the blows. But what about the ability of the battleship to *take* punishment? How does anyone really know what would happen if a MODERN battleship is *shot at* by modern ordnance?

When we have built five battleships to *shoot*, why not build one to be *shot at?*

Our Navy requests an obsolete battleship for a target. They are tired of "punching bag" performance, and want to see what will happen, even to an out-of-date ship. A storm of protest is invoked. Too expensive! Waste of money! When, through their superior marksmanship, they sink that ship, even the State she was once named for is offended!

An obsolete vessel "in reserve" would stand about as much show in an engagement with modern warships as a foundered horse in a race.

I suppose you are beginning to wonder what all this has to do with a Storage Battery.

Mr. Edison is in the same frame of mind, after repeated experiments with things that look feasible on paper, and under parlor test, as the United States Government will be after we have been up against a first-class Power. He is our "Congress" of, say, the year 1950.

When he had developed the Edison Storage Battery to the point of being able to shoot a large amount of energy from a small package, he wanted to know what effect the projectiles of general neglect and downright abuse would have. So, *before* he launched his *modern* Dreadnought to *shoot*, he constructed several thousand "protected cruisers" to be *shot at*. Some of these he placed in the hands of outsiders to test in practice. This was about six years ago. *Some* of them are running today. *All* of them are not.

So he was dissatisfied. His armor had been penetrated. He stopped manufacturing, BOUGHT BACK AT PRICE CHARGED ORIGINALLY ALL HE COULD GET USERS TO GIVE UP, and kept up his experiments.

Finally, the present Dreadnought was produced, three and one-half years ago. She is still on the firing line, and is vanquishing all foes. No dents in her armor.

Larger projectiles have been fired at her from our own Laboratory guns than will ever be directed against her by others. I am going to tell you of the results of all these "salvos" in due course. Am producing herewith a curve showing the electrical capacity *before* the cell was dropped 1,776,000 times onto an oak block, and after the test. Naturally, had any of the active material been jarred from the plates during this test, the capacity would have been diminished. *It was not.*

A battleship and a storage battery are in the same class, in their respective spheres of usefulness. Both must *withstand hard knocks.* Both must be designed from the standpoint of possible improvements in "ordnance." While I have not in mind at the present moment any use to which a storage battery will be put, in which it will receive the actual abuse of being raised one-half inch from an oak block, and dropped 1,776,000 times, there is no telling *when* it will be subjected to such abuse. After all, there is very little difference between this treatment and the treatment a battery receives when placed in a COMMERCIAL TRUCK which is being driven over cobble-stone pavements. The springs of the truck are made strong to support the load. IT IS NOT ALWAYS LOADED. Hence, the vibration is transmitted through the stiff springs to the battery. The battery that will stand up to this *dropping test* will certainly stand up to such vibration as it will receive in *any vehicle.*

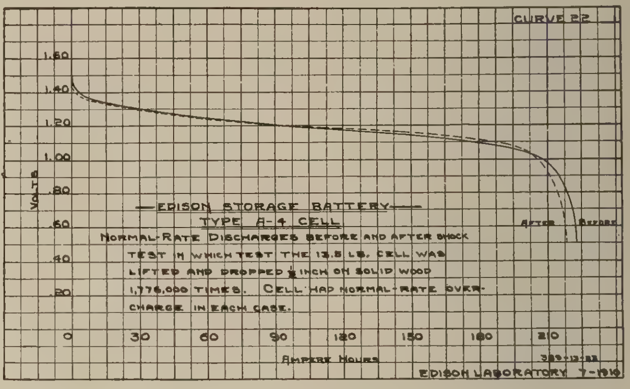


Fig. 17.

The Edison Storage Battery is a battleship designed and constructed to withstand improvements in diabolical projectiles of human abuse for many years to come, and has been "shot at" to prove it—which is one better than the Navy can go with its battleships until somebody starts something.

Bucking Center

In the early part of January, 1912, Patrolman James J. Redmond, of New York, suffered serious internal injuries in stopping a runaway team. On January 15, while lying in his bed at home, encased in a plaster cast, his life despaired of, a young woman ran into his room screaming, and imploring his protection from her insane husband, who was endeavoring to murder her.

Redmond succeeded in reaching the bureau, where his revolver reposed in a drawer. His effort was heroic. His limbs were useless. Only by dragging himself across the floor did he accomplish it.

Just as the would-be murderer entered the room Officer Redmond covered him, and summoned assistance by firing his revolver over his head.

An employee of a large manufacturing company was recently summoned to his home, because of a fatal accident to his only child. The young mother was prostrated by the shock, and herself at death's door. This magnificent specimen of physical manhood proceeded to improve conditions by leaving his desolate home and spending in a corner saloon the little money his wife had saved from the last week's wages.

Quite a difference between these two men.

In storage battery parlance, Redmond experienced a severe short-circuit, and did not buckle his plates or shed his active material.

The other man did.

Which do you admire more?

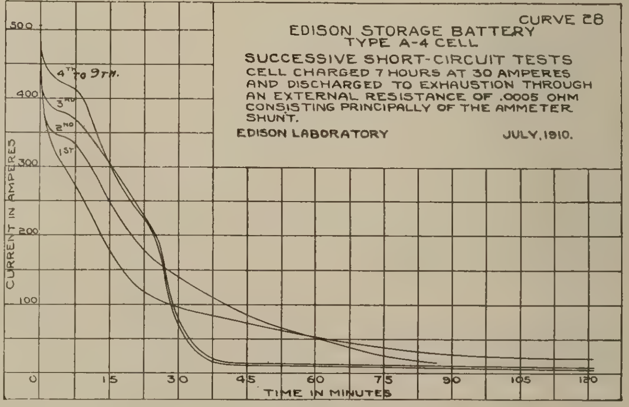


Fig. 18.

A feat of heroism—the ability and grit to stand up against heavy odds, not only excites the admiration and respect of all mankind, but is an attribute which insures for the fortunate possessor success in life.

A subscription for Officer Redmond's benefit would have been oversubscribed. The World loves to show its appreciation of true worth.

If this feeling obtains in recognition of human valor, it is difficult to understand why it should not also obtain for the HANDIWORK of man.

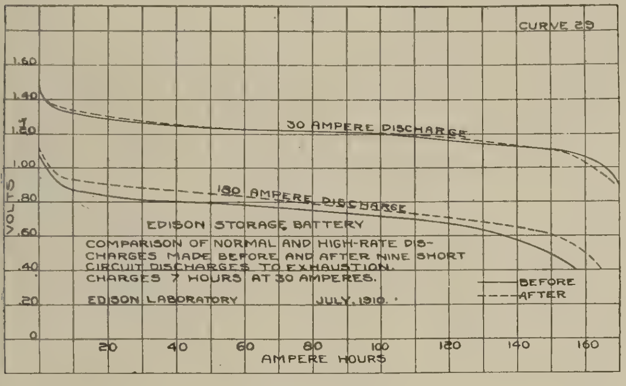


Fig. 19.

People place their valuables in vaults of steel, so they will not be troubled with watching them. It costs more money to place our money in the safe-keeping of a safe deposit vault than it does to let it lie unguarded in our homes.

It costs more money to buy an Edison *Steel* Battery, which safeguards your investment, than it does to buy a battery which does not safeguard your investment.

The ammeter may be entirely removed after the proper equipment of Edison Storage Battery has been installed. All we are interested in is that the size of battery be proportioned to the average load, in order that maximum efficiency may result.

There is but one answer for a battery that will not stand up under adverse treatment.

Curve Fig. 18 shows the performance of an Edison Cell, selected at random from stock, and SHORT-CIRCUITED FOR NINE SUCCESSIVE RUNS TO EXHAUSTION. It is interesting to note the capacity *increased* with each run.

Curve Fig. 19 is a record of the capacity of the cell at normal discharge, and at six times normal discharge rate, BEFORE AND AFTER THE NINE SHORT-CIRCUITS. IT ACTUALLY IMPROVED!

From the foregoing, one cannot but agree with us that the Edison Battery is in the same class with Patrolman Redmond.

There are a great many Edison Cells in use for calibrating house meters. This necessitates a very heavy current, amounting practically to a short-circuit. The Inspector carries one or two cells with him. Practically every discharge of these cells is on dead short-circuit. We have not heard any complaints from the owners of them.

Doing Things Backward

Some human beings are born dead, thereby covering the maximum scope of inverse action, and getting through with it in a hurry.

A great many others string it out.

Since Time began, the fair sex have stepped from moving vehicles with their faces to the rear. The awakening is sudden, but the practice keeps up.

Instead of piling up a balance in the bank, some people prefer debts and the Bankruptcy Court.

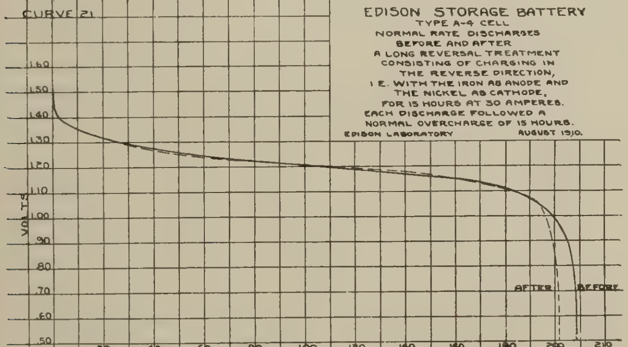


Fig. 20.

The Divorce Court tells its story of the disagreements *after* the agreement, with the attendant injustice to the children.

The more we think on the subject, the greater is our belief in Darwin's Theory. The most of us can trace a direct lineage from the original monkey that swam a river of crystal pure water, in order that he might partake of a drink thereof on the opposite bank.

Owing to this universal tendency of doing things backward, it devolves upon the man who produces apparatus for the use of all humanity to provide against it.

The most important of all directions accompanying ordinary batteries is, "Extreme care must be exercised in connecting the battery to the charging circuit, so that the current will flow from the positive wire of the circuit to the positive terminal of the battery, thence through the battery, to the negative terminal and to the negative wire of the circuit."

One would think that a battery in the hands of electrical engineers would never be connected up improperly.

Some months ago we shipped a battery of Edison Cells to the laboratory of a renowned scientist. After using it several weeks he decided to discharge the battery to zero, and then, after letting it stand over night short-circuited, plot a curve of potential difference from total discharge to full charge.

He turned the battery over to his assistants to charge up, after the short-circuit test. The charging terminals were accidentally reversed, and that battery was charged in *reversed direction* for 48 hours at normal charge rate. The assistant was unable to account for the peculiar curve resulting, and called the attention of the Chief to the performance. He found the mistake.

Hoping against hope, and with a full realization of what would have happened to any other battery from such treatment, the battery was recharged in the proper direction, and showed, after three cycles, *considerably more than rated capacity on discharge.*

Please examine curve Fig. 20, taken from Mr. Edison's personal files. You will see that the Edison Type A-4 Cell of 150 ampere-hour rating has the same capacity after being overcharged in a reverse direction for fifteen hours at normal rate of 30 amperes, as it had before this "Rabbit in the Briar Patch" treatment.

Negligence

Negligence! The Ace of Human Frailty. The attribute to which more of the woes of Mankind are due than to all others.

Orphan Asylums, Alms Houses, Divorce Courts, Railroad Accidents, Ship Disasters, Junk Heaps—ALL are monuments thereto.

We boast of an advanced civilization. We preach the doctrine of self-control and "providing against that day." As a matter of fact, nine-tenths of us are considerably overdue at our dentists. The last time we had a prolonged session with him—a session replete with rubber dams (and another kind spelled differently)—we promised him, and promised ourselves, we would go around about once every six months and have our teeth looked over. We know, as well as we know anything, neglect of

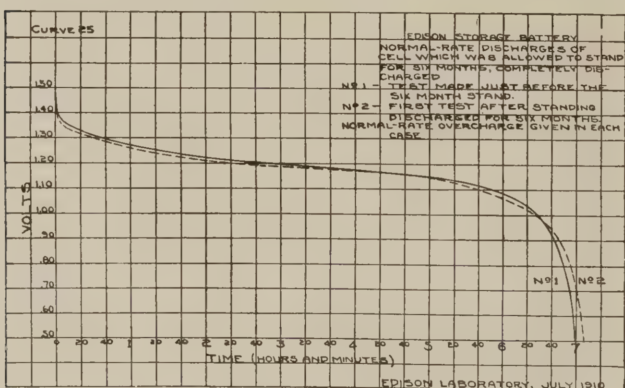


Fig. 21.

the teeth will not only result in suffering, but we will be unable to replace them when they have gone. Yet we delay, NEGLECT, until a tooth gets obstreperous, and then expect the dentist to go to work at 2 A. M.

Now, if we will persistently neglect part of our own human machinery—a part which asserts itself—there is little wonder we fail to shower attentions on the batteries in car lighting service, on our automobiles, electric trucks, etc.

The junk man knows this.

When Mr. Edison started in to provide a SURE-ENOUGH storage battery, he had this predominant trait of Human Nature more strongly in mind than any other. He wished to go Nature one better and give Mankind something which CAN be neglected to a very large extent—a steel tank for storing electricity and which can be left filled or empty for protracted periods without having to take it all apart and put it up in curl papers. A practical battery that can say to this Demon Negligence, "Go as far as you like, for all I care, and when you think of it, dust me off and give me a drink of water now and then."

It becomes necessary for me to prove my assertions, to show a few curves which were plotted from tests Mr. Edison had made for his own information. To many of you, a curve is self-explanatory. To others, it is not. It is therefore necessary that I explain in non-technical language:

Suppose a man, in good health and vigor, starts to run as fast and as far as he can. For the first few seconds, he makes great speed. Then he commences to slow up a little, the speed slackening as he proceeds. Finally he desists, utterly exhausted. A curve of his performance

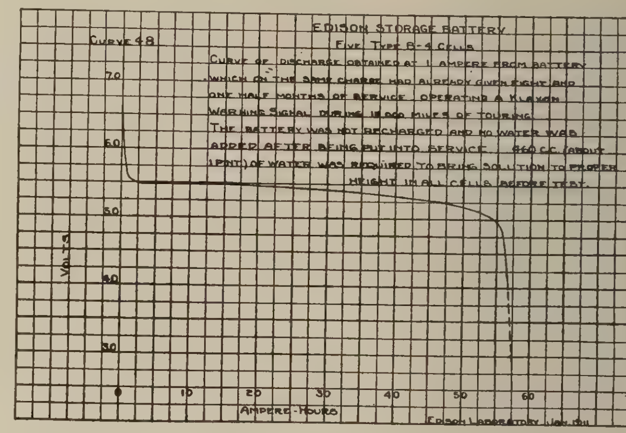


Fig. 22.

would probably very much resemble the solid black curve of Fig. 21. At the upper left hand corner, he is running fast. Then his speed slackens, gradually lessening, until at "7" he stops.

Now suppose he goes to bed and remains there, IN A PLASTER CAST, for six months. It would be impossible for him, at the end of such period, to throw off his

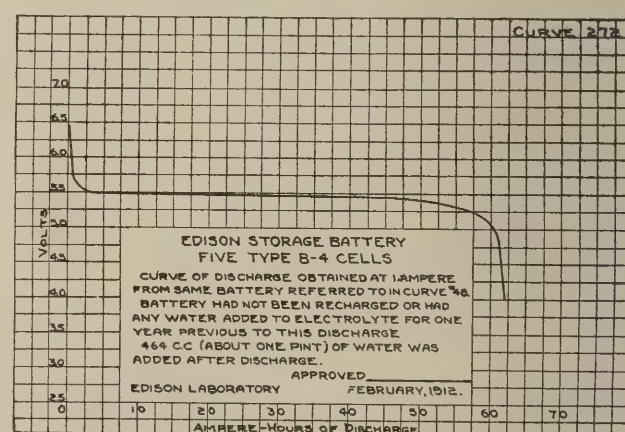


Fig. 23.

cast, eat a good meal, and run as fast and as far as he did before. Through inactivity—neglect—his muscles and entire body have become weakened.

Yet, it is demonstrated by the dotted line curve of Fig. 21, AN EDISON STORAGE BATTERY CAN BE DISCHARGED TO ZERO, SHORT-CIRCUITED, AND LEFT STANDING WITHOUT ATTENTION FOR SIX MONTHS, AND WHEN CHARGED AGAIN, WILL PRACTICALLY DUPLICATE THE INITIAL PERFORMANCE.

There is no other battery in the World which will even approximate this performance.

As the inventor of the Klaxon Horn, I had, in the beginning, heard some complaints that ordinary storage batteries would not operate it for more than a month without being recharged. I could not blame the Klaxon,

because by figuring a little I found an 80 ampere-hour battery should blow the Klaxon 41,000 times. It did not seem reasonable that any automobilist could blow his horn 41,000 times in a month. So, on May 1st, 1910, I placed a B-4, 80 ampere-hour, 6½ volt Edison Ignition Battery on my automobile, to operate my Klaxon. From then to January 15th, 1911—eight and one-half months—I toured for about 12,000 miles, blowing the Klaxon when necessary as a warning of danger. Not once did I charge the battery. I put no water into it.

On January 15th, 1911, curious to see how much capacity remained, I removed it from the machine and put in on discharge. Of the original eighty-ampere-hours rated capacity, I took out FIFTY-FIVE AMPERE-HOURS. See Curve Fig. 22.

Water was added, the battery recharged, and again placed on the machine on February 1st, 1911. After operating the Klaxon for an entire year's travel, it was again removed and discharged. This time, SIXTY ampere-hours remained in it. See Fig. 23.

New solution has been added, the battery recharged, and I expect to use it another year without replenishing or recharging.

THIS IS VERY GOOD INDICATION THAT THE EDISON BATTERY CAN BE CHARGED AND LEFT STANDING WITHOUT MUCH LOSS OF CAPACITY AND WITH NO DETRIMENT.

The "San Francisco Post" of March 25th, 1912, states as follows:

> "The Act of Congress in relation to wireless for deep water vessels, also requires that vessels must be equipped with auxiliary batteries, independent of the main dynamo, which works the wireless apparatus. So that in the event of the engine-rooms being flooded or the machinery put out of commission in any other manner, the wireless operator will be able to work his instrument by means of the auxiliary or storage battery. The time for the installation of the auxiliary battery was extended to July 1st, 1912.
>
> "Inspector Cadmus, accompanied by Assistant Manager Isabell of the United Wireless, returned today from Seattle. They left here on the Steamer President, March 16th, and made many tests with the EDISON AUXILIARY WIRELESS BATTERY. They found that with EIGHT CELLS (Type B-4 80 ampere-hour) they could freely communicate with vessels ranging in distance from 100 to 229 miles at sea (in the daytime). They also made record tests with shore stations, all of which proved satisfactory. Altogether, they made more than fifty tests with the Edison Battery, operating independent of the main dynamo. With the auxiliary battery, the wireless operator can keep his instrument working as long as he and his instruments remain above water."

The battery referred to was charged early in February and sent to Mr. R. Y. Cadmus, Wireless Ship Inspector of the Pacific Coast. Almost two months after, it performed as above indicated.

WILL THE EDISON BATTERY BE USED FOR SUCH EMERGENCY WORK?

That remains to be seen.

It COSTS more than other batteries. A few dollars are sometimes allowed to stand between reliability and unreliability, even when human lives are at stake.

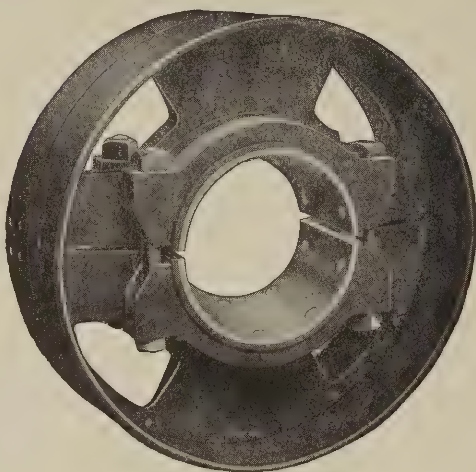
(To be continued next month.)

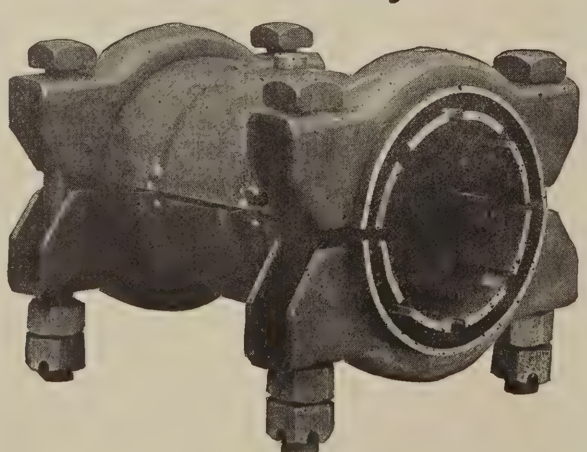
Notice.—This is one continued story of 4 installments which began in the March issue of the Railway Electrical Engineer. To avoid repetition, I am referring to cuts previously shown. It is therefore desirable that each issue of the Railway Electrical Engineer be filed for reference.

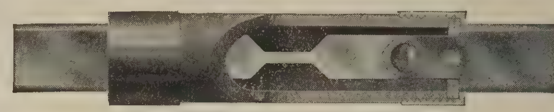
Respectfully,

MILLER REESE HUTCHISON,
Chief Engineer to and
Personal Representative of
Thomas A. Edison

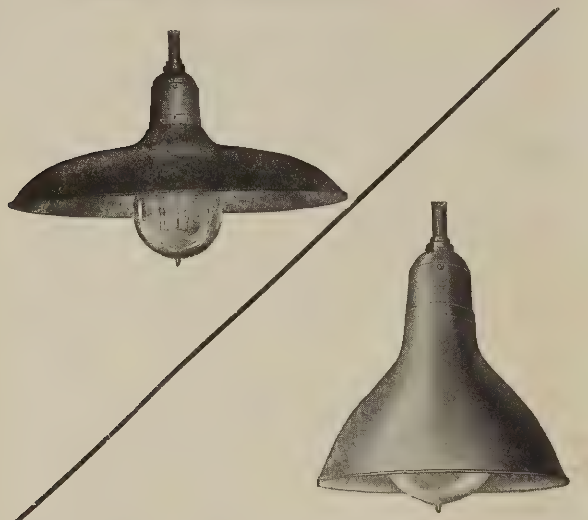
Dictated to the Edison Dictating Machine.







Light Savers



ABOLITES

You are very careful about saving material in your shop---but how about the light?

If you have strong light in places where only medium strength is needed, if you are using the same reflector on all your lamps, you are wasting light---and light costs money no less than material.

ABolites are Light Savers

When you install them you can give every man at every machine just the amount of light his work requires, and the reflector will throw the light in places where it is needed.

Each ABolite will take any power Mazda Lamp from 25 to 500 watt. Both the shape and position of the reflector can be changed to suit the work.

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in the
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needs good light above all thimgs: his eyes are in constant use and under the most trying conditions. The motion of the car makes reading difficult and the inadequacy of windows necessitates almost continual use of artificial light. Unless that light is properly directed and diffused, so that there are practically no shadows in his way, the postal clerk works with strained eyes. That means inevitably, headache, slow-speed and impaired efficiency.

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Dope Sheet

IRON WORKING MACHINERY,
Power to Drive PLANERS.

Test of power required to run Pond planer, 35' X 5'-4" table, 59'-11" bed; run by motor, 500 volt, compound wound, belted to counter shaft. Speed of cut 20 ft. per min. - return 50 ft. per min. Efficiency of motor taken as 85%. Return stroke not included in calculation of metal removed per minute. Cutting wrought iron slabs.

K.W.	Elec. h.p.	Mech. h.p.	Tools	Depth in.	Feed in.	Square Inches	Cubic Inches Removed Per Min.	Cu. ins. Removed Per h.p. Per Min.	Rake of Tool.
4.24	5.7	5.0	0	0	0				
22.45	30.1	25.5	1	5/8	1/4	.1562	37.48	1.48	15 deg.
41.87	56.1	47.6	1	5/8	1/4	.3281	78.74	1.65	"
			1	11/16	1/4				
25.00	33.5	28.4	1	3/4	1/4	.1875	45.00	1.58	25 deg.
33.20	44.5	37.8	1	3/4	3/8	.2813	67.51	1.78	"
38.60	51.9	44.0	1	3/4	1/2	.3750	90.00	2.02	"
47.70	64.0	54.1	3	1/2	1/4	.3750	90.00	1.66	"

IRON WORKING MACHINERY,
Power to Drive PLANERS.

Size	Drive	No. of Cutting tools	Size of cut inches.	Cutting Speed in ft. Per Min.	Material	Ratio of cutting to return speed.	H.P. to Drive. Cutting Stroke	Reverse to return.	Return Stroke	Reverse to cut.
36"	Belted	2	3/64 X ½ - 3/64 X ¼	29.1	S.	1:3	7.0	10.3	7.6	7.1
60"	Belted	2	Heavy rough cut	18.0	C.I.	1:3	7.0	18.3	4.9	9.2
84"	Belted		Running light	18.2		1:3	2.4	19.7	4.8	17.8
120"	Direct Driven	2	3/16 X ½ - 3/16 X ½	18.0	C.I.	1:3	11.3	23.8	4.4	11.9
120"	Direct Driven		Running light	18.0		1:3	3.6	24.4	4.2	11.7
120"	Belted	1	3/16 X 3/16	16.0	C.I.	1:3	6.6	32.6	5.6	20.3
120"	Belted		Running light	18.0		1:3	3.1	34.7	4.9	20.0
120"	Belted		Running light	18.7		1:4	3.6	17.2	6.9	5.8

IRON WORKING MACHINERY,
Power to Drive PLANERS.

Test of 10' X 10' Pond Planer with electric motor drive.

Cutting speed of tools, feet per minute	18.75
Feed	3/32
Number of tools cutting	2
Depth of cut, Diamond pointed tools	1¼
Area of cut, square inches, each tool	.1171875
Square inches for two cuts	.234375
Average electric horse-power	32.99
Maximum " " "	35.85
Electric horse-power required on reversing machine	50.67

The motor was not tested to its full capacity.

Note:- Only two of a possible 4 tools were cutting.

IRON WORKING MACHINERY,
Power to Drive PLANERS.

Power required to drive 3 plainers in wheel shop. Sizes 36" X 36" X 10'. Tested while doing regular work on driving boxes driven by 20 h.p. induction motor belted to shafting. Planer belted in regular manner.

Work Done.	Ft. Per Min.	Av. H.P.
Shafting and motor		3.4
No. 1 planer 3/16" X ½" cut - Cast Iron	34	7.1
" 1 " Reversed	50	6.7
" 2 " 1/8" X 1/16" cut - Cast Steel	40	7.2
" 2 " Reversed	75	6.7
" 3 " 1/2" X 3/32" cut - Cast Steel	40	6.8
" 3 " Reversed	75	
" 1 and 3 Cutting		18.0
" 1 " 3 Reversed		11.0
" 2 " 3 Cutting		11.5
" 2 " 3 Reversed		9.5
" 1,2 and 3 Cutting		15.5
Test with other sets of driving boxes.		
" 1,2 " 3 Cutting, cuts 5/32"X3/8"C.I. 1/32"X ½"C.S. 1/32"X5/16"C.S.		21.7
" 1 and 2 "		17.0
" 2 " 3 "		14.5
" 1,2 and 3 Reversed.		14.3

The above are average readings of about 6 strokes of planers.

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The next convention of the Association will be held at Atlantic City, N J., June 11, 1912. The annual convention will be held in Chicago, October 21-25, 1912.

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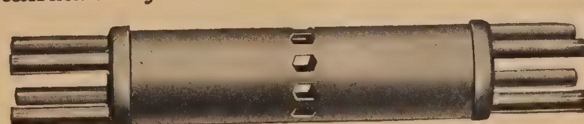
D&W

And the Standard by which all Enclosed Fuses are Measured



Construction of Link used in fuses in operating under severe conditions.

"D & W" Fuses are Scientifically designed

have maximum surface with a resultant minimum volume of metal for a given current value. This enables fuses of reasonable dimensions to meet abnormal conditions of overload. The fibre tubes are exceptionally strong, and are fitted with steel reinforcing rings when necessary.

D&W

Specify them on your installation and you will get the protection you ought to have.

D&W

Catalog containing full particulars is yours upon request.

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of Service

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